IS 15750 (2006): Household frost-free refrigerating appliances - Refrigerators cooled by internal forced air circulation - Characteristics and test methods [MED 3: Refrigeration and Air Conditioning]

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भारतीय मानक

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Indian Standard

HOUSEHOLD FROST-FREE REFRIGERATING APPLIANCES — REFRIGERATORS COOLED BY INTERNAL FORCED AIR CIRCULATION — CHARACTERISTICS AND TEST METHODS — SPECIFICATION

ICS 97.040.30

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Price Group 13

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Refrigeration and Air-conditioning Sectional Committee had been approved by the Mechanical Engineering Division Council.

While preparing this standard, assistance has been derived from the following standards:

a) ISO 15502 : 2005 (E) 'Household frost-free refrigerating appliances —Characteristics and test methods' issued by the International Organization for Standardization (ISO)

b) AS/ANZ 4474.1 : 1997 'Performance of household electrical appliances — Refrigerating appliances — Part 1: Energy consumption and performance' issued jointly by the Standards Australia and Standards New Zealand

ISO 15502 covers four climatic classes, namely SN, N, ST and T whereas this standard covers only tropical class (T), which is applicable to India.

The classification given in ISO 15502 : 2005 is given below for guidance:

Class	*Symbol*	*Range of Ambient Temperatures on which the Appliances are Intended to be Used, and for which the Required Storage Temperatures shall be Fulfilled* °C
(1)	(2)	(3)
Extended temperate	SN	+10 to +32
Temperate	N	+16 to +32
Subtropical	ST	+16 to +38
Tropical	T	+16 to +43

Minimum Energy Performance Standards (MEPS) given in **5.2.3.1** correspond to 1 star rating specified by the Bureau of Energy Efficiency.

The requirement of additional marking given in **24.2** would be reviewed when Energy Labelling becomes mandatory under *Energy Conservation Act*, 2001.

A scheme of labelling environmentally friendly products with ECO logo known as ECO-Mark has been introduced at the instance of Ministry of Environment and Forests (MEF), Government of India. The ECO-Mark would be administered by the Bureau of Indian Standards (BIS) under the *Bureau of Indian Standards Act,* 1986 as per Resolution No. 71 dated 21 February 1991 and No. 425 dated 28 October 1992 published in the Gazette of India. The Ministry of Environment and Forests, Government of India, issued a Notification dated 17 May 1996 [GSR 214(E)] for ECO labelling of refrigerators. These ECO labelling criteria relevant to refrigerators have been incorporated in this standard.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the results of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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Indian Standard

HOUSEHOLD FROST-FREE REFRIGERATING APPLIANCES — REFRIGERATORS COOLED BY INTERNAL FORCED AIR CIRCULATION — CHARACTERISTICS AND TEST METHODS — SPECIFICATION

1 SCOPE

This standard specifies the essential characteristics for household refrigerator and refrigerator-freezer cooled by frost free system and lays down the methods of test for the checking of these characteristics. This standard does not apply to household refrigerator-freezer not cooled by internal forced air circulation.

Appliances with one refrigerating system in which there are compartments, some cooled by forced air circulation and others by natural convection, shall be tested in accordance with this standard. However, all compartments are automatically defrosted with automatic disposal of the defrost water.

Appliances covered by this standard may also incorporate special compartments for the storage of highly perishable foodstuffs and ice tray compartments.

The tests described in this standard are type tests. When it is necessary to verify the performance of a refrigerating appliance of a given type in relation to this standard, all the tests described should in principle be applied to one and the same unit, wherever possible. These tests can also be made individually for the study of a particular characteristic.

Where no test method is specified, the particular requirement concerned is to be considered as a recommendation.

The electrical and mechanical safety requirements applicable to household refrigerating appliances are specified in IS 302-2-24.

Additional safety requirements applicable to the refrigerating systems of household refrigerating appliances are given in IS 660. This standard does not apply to household frost-free refrigerating appliances operating on energy sources other than electricity.

2 REFERENCES

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
302-2-24 : 1992	Safety for household and similar electrical appliances: Part 2 Particular requirements, Section 24 Refrigerators, food freezers and ice-makers
660 : 1963	Safety code for mechanical refrigeration
1060 (Part 1) : 1966	Method of sampling and test for paper and allied products: Part 1 (*revised*)
10609 : 1983	Refrigerants — Number designation

3 DEFINITIONS

For the purpose of this standard, the following definitions shall apply.

3.1 Household Frost-Free Cooling Appliances — Insulated cabinet of suitable volume and equipment for household use, in which all compartments are automatically defrosted with automatic disposal of the defrost water, and at least one compartment is cooled by a frost-free system (*see* **3.1.5**).

3.1.1 *Household Frost-Free Refrigerator (Herein After Referred to as 'Refrigerator')* — Frost-free appliance having one or more compartments intended for the preservation of food, one at least of which is suitable for the storage of fresh food.

3.1.2 *Household Frost-Free Refrigerator-Freezer (Herein After Referred to as 'Refrigerator-Freezer')* — Frost-free appliance having two or more compartments.

At least one compartment (the fresh food storage compartment) is suitable for the storage of fresh food, and at least one compartment (the food freezer compartment) is suitable for freezing fresh food and for the storage of frozen food.

3.1.2.1 *Household refrigerator-freezer type I* — A refrigerator-freezer having a single temperature control device for regulating the temperatures of the fresh food storage and food freezer compartments.

3.1.2.2 *Household refrigerator-freezer type II* — A refrigerator-freezer having the means for separate regulation of the temperatures of the fresh food storage and food freezer compartments.

3.1.3 *Household Frost-Free Frozen Food Storage Cabinet (Hereinafter Referred to as 'Frozen Food Storage Cabinet')* — Frost-free appliance having one or more compartments which is (are) suitable for the storage of frozen food.

3.1.4 *Household Frost-Free Food Freezer (Hereinafter Referred to as 'Food Freezer')* — Frost-free appliance having one or more compartments suitable for freezing, from ambient temperature to –18°C.

NOTE — From the point of view of installation, there are various types of household refrigerating appliances: freestanding, wall-mounted, built-in, etc.

3.1.5 *Frost-Free System* — System in which cooling is provided by forced air circulation and the evaporator(s) is (are) defrosted by an automatic defrost system. Characteristics of the 'frost-free' system are:

a) The system is automatically operated to prevent the permanent formation of frost on all refrigerated surfaces;
b) No accumulation of ice or frost forms on the stored food;
c) Storage temperatures in the fresh food compartment, the frozen food storage and/or freezer compartment and the cellar compartment (if any) are maintained within the limits specified in this standard; and
d) The water from defrosting is disposed of automatically.

3.2 Compartments and Sections

3.2.1 *Fresh Food Storage Compartment* — Compartment intended for the storage of unfrozen food, which may be itself divided into sub-compartments, and in which the temperatures can be maintained in accordance with **5.2.1**.

3.2.2 *Cellar Compartment* — Compartment intended for the storage of particular foods or beverages at a temperature warmer than that of the fresh food storage compartment, and in which the temperatures can be maintained in accordance with **5.2.1**.

3.2.3 *Chill Compartment* — Compartment intended specifically for the storage of highly perishable foodstuffs in which the temperatures can be maintained between –2°C and +3°C.

3.2.4 *Ice-Making Compartment* — Compartment intended specifically for the freezing and storage of water ice-cubes.

3.2.5 *Frozen Food Storage Compartments* — Compartments intended specifically for the storage of frozen food at –18°C.

3.2.6 *Food Freezer Compartment* — Compartment suitable for freezing from ambient temperature to –18°C under the test conditions specified in **16**.

3.3 General Definitions

3.3.1 *Top-Opening Type* — Appliance in which the compartment(s) is (are) accessible from the top.

3.3.2 *Upright Type* — Appliance in which the compartment(s) is (are) accessible from the front.

3.3.3 *Overall Dimensions (Doors or Lids Closed)* — Measurements of the rectangular parallelopiped, whose base is horizontal, within which the appliance is inscribed to include the complete appliance except for the handle, the protrusion of which, if any, is to be specified separately.

3.3.4 *Overall Space Required in Use (Doors or Lids Open)* — Overall dimensions including the handle, increased by the space necessary for free circulation of the cooling air when the appliance is in service, plus the space necessary to allow opening of the means of access to that minimum angle permitting removal of all removable parts such as containers and shelves (*see* Fig. 1).

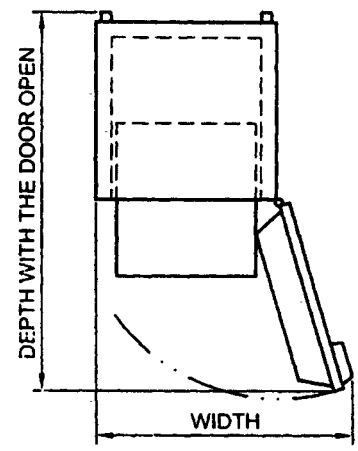


FIG. 1 OVERALL SPACE REQUIRED IN USE (UPRIGHT TYPE)

3.3.5 *Volumes*

3.3.5.1 *Gross volume* — The volume within the inside liner of the refrigerating appliance or of a compartment with an external door, without internal fittings and with doors or lids closed.

3.3.5.2 *Rated gross volume* — Gross volume stated by the manufacturer.

3.3.5.3 *Total gross volume* — Sum of the gross volumes of the fresh food storage compartment(s), low-temperature compartment(s), food freezer compartment chill compartment(s) and cellar compartment(s), as applicable, even if their door or lids are independent.

3.3.5.4 *Rated total gross volume* — Total gross volume stated by the manufacturer.

3.3.5.5 *Storage volume* — That part of the gross volume of any compartment which remains after deduction of the volume of components and spaces recognized as unusable for the storage of food, determined by the method given in **6.2.**

3.3.5.6 *Rated storage volume* — Storage volume stated by the manufacturer.

3.3.5.7 *Total storage volume* — Sum of the storage volumes of the appliance, comprising the storage volumes of the fresh food storage compartment(s), low-temperature compartment(s), food freezer compartment, chill compartment(s) and cellar compartment(s), as applicable.

3.3.5.8 *Rated total storage volume* — Total storage volume stated by the manufacturer.

3.3.6 *Storage Surface*

3.3.6.1 *Shelf* — For the purpose of this standard, a shelf is any horizontal surface (shelves, partitions, etc) on which food can be placed.

It may be formed by one component or by components fitted side-by-side, which may be fixed or removable.

3.3.6.2 *Storage shelf area* — Sum of the horizontal projections of the storage surfaces within the storage volume including door shelves and the bottom of each compartment, determined in accordance with **6.3.**

3.3.6.3 *Rated storage shelf area* — Storage shelf area stated by the manufacturer.

3.4 Definitions Relating to Some Performance Characteristics

3.4.1 *Energy Consumption* — Consumption of an appliance over a period of 24 × 365 h running under stable operating conditions at an ambient temperature of + 32°C and measured under the conditions specified in **14.**

3.4.2 *Rated Energy Consumption* — Energy consumption stated by the manufacturer.

3.4.3 *Storage Temperatures*

3.4.3.1 *Fresh food storage temperature,* t_m — Arithmetical average of the instantaneous temperatures t_1, t_2 and t_3 measured with temperature sensing probes placed at given points in the fresh food storage compartment as specified in **7.4.**

$t_{m, Max}$ is the maximum value of t_m.

3.4.3.2 *Frozen food storage temperature* — Measure the instantaneous temperatures t_1, t_2, t_3, t_4, *and* t_5 with temperature sensing probes placed at given points in the frozen food storage compartment as specified in **7.5.** Delete the coldest temperature out of the five observations. Take average of the remaining four observations.

3.4.3.3 *Cellar compartment temperature,* t_{cm} — Arithmetical average of the instantaneous temperatures t_{c1}, t_{c2} and t_{c3} (as appropriate) measured by the sensing probes placed at given points in the cellar compartment as specified in **7.4.**

$t_{cm, Max}$ is the maximum value of t_{cm}.

3.4.3.4 *Chill compartment temperatures,* $t_{cc, Max}$, $t_{cc, Min}$ — Maximum and minimum instantaneous temperatures measurements in the chill compartment.

3.4.4 *Defrosting*

3.4.4.1 *Automatically defrosted* — An evaporator is a automatically defrosted where no action is necessary by the user to initiate the removal of frost accumulation or to restore normal operation, and where the disposal of the defrost water is automatic.

3.4.4.2 *Automatic disposal of defrost water* — Disposal of defrost water is automatic where the removal and the evaporation of the defrost water does not require any action by the user.

3.4.5 *Cycles*

3.4.5.1 *Operating cycle* — That period which commences at the initiation of a automatic defrosting cycle and terminates at the moment of initiation of the next automatic defrosting cycle.

3.4.5.2 *Defrosting cycle* — The period between the moment when the means of defrosting the evaporator(s) is switched on and the moment when the refrigeration process is re-established.

3.4.6 *Stable Operating Conditions* — Stable operating conditions exist when the appliance's mean temperatures and energy consumptions are stable. Stability means variation in the compartment temperature is not more than ±0.5°C for 3 h prior to initiation of defrosting and 3 h prior to next defrosting cycle.

3.4.7 *Percentage Running Time (Apparatus with On/Off Control for the Refrigerating Source)* — Under given conditions of ambient temperature and of internal

storage temperature, the percentage running time ratio '*R*' is expressed by

$$R = d/D \times 100$$

where

d = total duration of the refrigerating system operation during an operating cycle (*see* **3.4.5.1**); and

D = total duration of the operating cycle minus the duration of the defrosting cycle (*see* **3.4.5.2**), even if defrosting occurs by a hot-gas system (*see also* Fig. 2).

In the case of a refrigerating appliance having two independent refrigerating systems, there will be two values for percentage running time, one for the fresh-food storage compartment and one for the low-temperature compartment.

For appliances with a hot-gas defrosting system, the time required for hot-gas defrosting shall not be included in the running time of the refrigerating unit.

3.4.8 *Pull-Down Capacity* — The time required to bring down the temperatures specified in Table 1 for different sections/compartments simultaneously when the appliance is operated under no load condition.

3.4.9 *Ambient Temperature* — Temperature in the space surrounding the appliance under test. It is the arithmetical average of the mean value of temperatures t_{a1} and t_{a2}, measured at two points located 350 mm from the vertical centreline of the side walls of the appliance at 1 m above the floor line.

3.4.10 *Temperature Rise Time* — Time period needed to raise the temperature of food in frozen food compartment from –18°C to –9°C after the operation of refrigerator system has been interrupted.

3.5 Definitions Relating to the Refrigerating System

3.5.1 *Refrigerant* — Fluid used for heat transfer in a refrigerating system, which absorbs heat at a low temperature and a low pressure of the fluid and rejects heat at a higher temperature and a higher pressure of the fluid usually involving changes of state of the fluid.

3.5.2 *Cooling Device* — Device containing the evaporator or in thermal contact with the evaporator; it may be a device with fins or may be suitably shaped for the storage of frozen food or water ice-cubes.

3.6 Definitions Relating to Compression-Type Appliances

3.6.1 *Compression-Type Appliance* — Appliance in which refrigeration is effected by the vaporization at low pressure in a heat exchanger (evaporator) of a liquid refrigerant, the vapour thus formed being restored to the liquid state by mechanical compression to a higher pressure and subsequent cooling in another heat exchanger (condenser).

3.6.2 *Hermetically Sealed Motor-Driven Refrigerating Compressor* — Motor-compressor in which the compressor and the electric motor (or its moving parts at least) are enclosed in a shell rendered gastight by welding, brazing or other means such that dismantling is not normally possible after assembly. It does not include moving parts outside the shell.

3.6.3 *Hermetically Sealed Compressor Refrigerating System* — Complete system, essentially comprising a hermetically sealed motor-driven compressor, a condenser, a pressure-reducing device, an evaporator, and all other parts containing refrigerant permanently interconnected by the manufacturer by welding, brazing or other means.

3.6.4 *Refrigerant Compressor* — Mechanically operated component which withdraws refrigerant vapour from the evaporator and discharges it at a higher pressure to the condenser.

3.6.5 *Expansion Device* — Device in which the pressure of the refrigerant is reduced from that of the condensed liquid to that of the evaporator.

3.6.6 *Condenser* — Heat exchanger in which, after compression, vapourized refrigerant is liquefied by rejecting heat to an external cooling medium.

3.6.7 *Evaporator* — Heat exchanger in which, after expansion, the liquid refrigerant is vaporized by absorbing heat from the medium to be refrigerated.

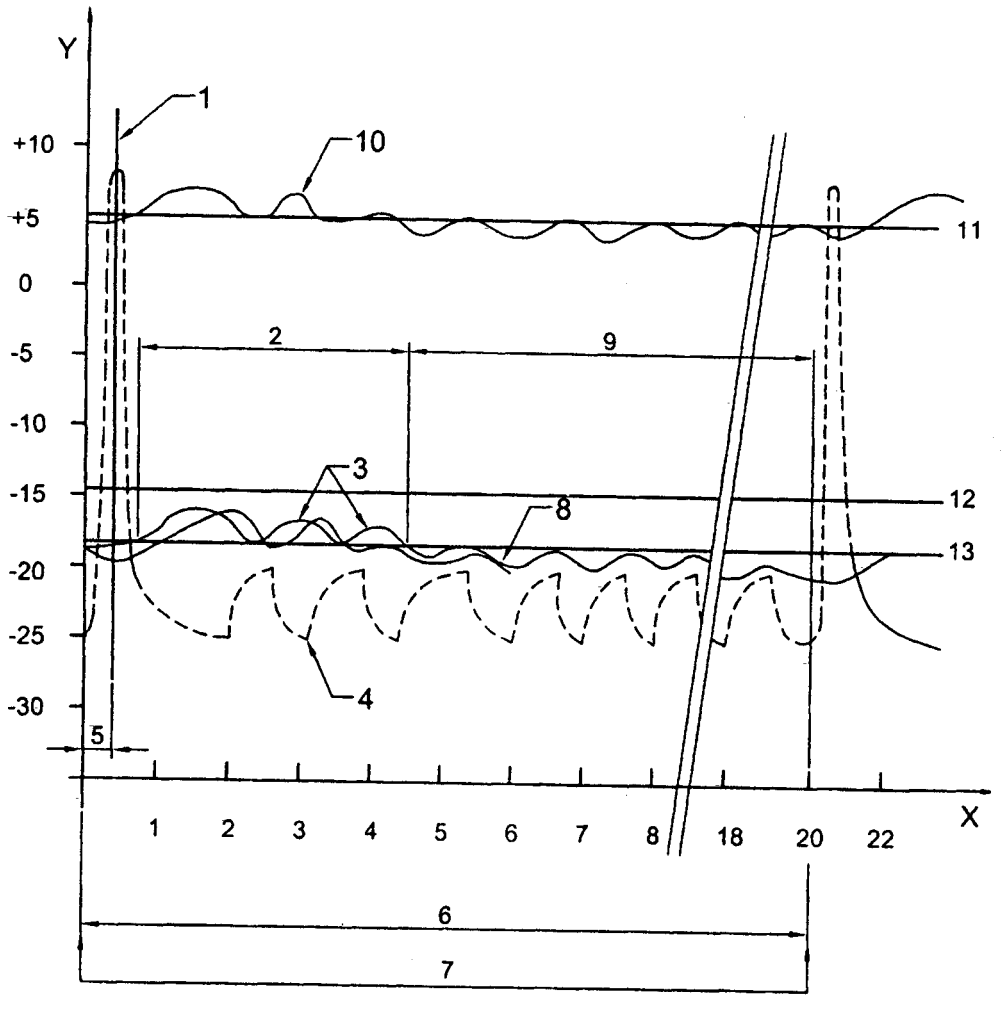
3.6.8 *Thermostat* — Device which automatically regulates the operation of a refrigerating system according to the temperature of an evaporator or of a compartment (or cabinet).

3.6.9 *Fan* — Device which provides cooling by means of a forced air stream to an evaporator/condenser and/or to one or more compartments of the appliance.

3.6.10 *Defrost Timer* — Device which controls the initiation, duration and time lapse between defrost cycles.

3.6.11 *Demand Defrost or Adaptive Defrost* — A form of automatic defrosting system where energy consumed in defrosting is reduced by an automatic process whereby the time intervals between successive defrosts are determined by an operating condition variable (or variables) other than, or in addition to, elapsed time or compressor run time.

3.6.12 *Defrost Heater* — Device which provides heat to the frost formed on the evaporator in order to facilitate the melting and removal of the ice.



KEY

X — time, h
Y — temperature, °C
1 — start refrigerating process
2 — period of 20 percent of the operating cycle of maximum 4 h when elevated temperatures are allowed for M-packages in the freezer compartment
3 — instantaneous temperatures of different M-packages
4 — temperature of evaporator
5 — automatic defrosting cycle
6 — operating cycle
7 — moment when the means of defrosting is switched on
8 — instantaneous temperature of the warmest M-packages
9 — period under which the conditions in Table 1 should apply, with the exeception of footnote *a*)
10 — t_a
11 — t_{ma}
12 — $t + 3K$
13 — t

FIG. 2 EXAMPLE OF OPERATING CYCLE FOR FROST-FREE REFRIGERATOR-FREEZER

Table 1 Storage Temperatures

[*Clauses* 3.4.8, 5.2.1 *and* 14.2.1(d)]

(Values in degrees Celcius)

	Fresh Food Storage Compartment (*see* 3.4.3.1)		Frozen Food Storage or Food Freezer Compartment (*see* 3.4.3.2)	Cellar Compartment (*see* 3.4.3.3)	Chill Compartment (*see* 3.4.3.4)
	t_1, t_2, t_3	t_m	t	t_{cm}	$t_{cc, Max, Min}$
Storage temperatures	$t_1, t_2, t_3 \leq +10$	$\leq +5$	≤ -18	$+8 \leq t_{cm, Max} \leq +14$	$t_{cc, Max} \leq +3$

NOTES

1 The duration of the temperature deviation above the storage temperature (line '1', *see* Fig. 2) as a result of a defrost cycle shall not be greater than 4 h or 20 percent of the duration of the operating cycle, whichever is the shorter.

2 In the case of t the duration of the deviation shall be measured from the moment when the first temperature measurement exceeds –18°C to that moment when the last temperature measurement returns permanently to –18°C or colder.

3 In the case of t_m, the duration of the deviation shall be measured from the moment when t_m exceeds +5°C to that moment when t_m returns permanently to +5°C or colder.

4 These two deviations need not occur simultaneously (*see* Fig. 2 for example).

4 MATERIALS, DESIGN AND MANUFACTURE

4.1 General

Appliances shall be constructed in such a manner as to ensure adequate performance and durability in use. Their performance in use is checked by applying a series of relevant tests.

This clause defines some characteristics which are not tested but to which the attention of the manufacturer is drawn.

4.2 Materials and Finishes

Materials used inside appliances shall not transmit odours or taste to food. When testing in accordance with **18**, the mean value of the individual results during each evaluation for odour and taste shall not exceed mark 1.

Materials used inside appliances shall not contaminate food placed in contact with them nor transmit poisonous substances to food. They shall be resistant to the action of moisture and food acids.

All surface finishes shall, for the purpose intended, be resistant to impact, sufficiently hard, colour-fast, smooth, easily washable, and resistant to damage by moisture and by food acids.

4.3 Thermal Insulation and Air Tightness

The thermal insulation of the appliance should be efficient and permanently maintained. In particular, the insulating material shall not be subject to shrinkage and shall not allow, under normal working conditions, an excessive accumulation of moisture.

No running water shall appear externally when the appliance is subjected to the water vapour condensation test specified in **13**.

When the door or lid is closed, there shall be no abnormal ingress of air into the interior.

A strip of paper shall not slide freely when door or lid seals are subjected to the air tightness test specified in **8**.

4.4 Doors, Lids and Fittings

Hinges and handles shall be strong and resistant to corrosion.

External doors and lids of fresh food storage compartments and chill compartments cellar compartments shall withstand 10 000 openings and closings without deterioration which may be prejudicial to the air tightness of the appliance when subjected to the durability test of **10**.

In the case of frozen food storage cabinets, food freezers and appliances with the food freezer compartment and the frozen food storage compartment, if any, having a separate access door or lid, the hinges and handles of the door or lid of that compartment (or cabinet) shall withstand 10 000 openings and closings.

The fastening system shall be such as to enable the door or lid to be easily closed and opened. It shall be efficient and capable of maintaining its proper function.

For appliances having any compartment or section with a volume equal to or greater than 60 litre, it shall be possible to open the door or lid of that compartment from the inside with a force not exceeding 70 N when subjected to the test specified in **9**. The volume of any compartment (or cabinet) or section shall be determined when all shelves; partitions and other internal components removable without the aid of a tool have been removed.

4.5 Shelves and Containers

Shelves, containers and similar components shall have adequate mechanical strength. Those used for storing food shall withstand the loading test specified in **11**

without showing such distortion that they could no longer fulfil their intended function. In particular, sliding or revolving components shall be capable of their full movement when loaded.

Shelves, containers and similar components which are intended to be removable should be easily removable.

4.6 Disposal of Defrost Water

A means shall be provided for completely collecting the defrost water in an external receptacle wherein the defrost water is evaporated.

The defrost water receptacle should have adequate volume and should have adequate evaporating means.

Any drainage system shall be designed to ensure its proper function. It shall be easily accessible for the clearing of any blockage, and shall be designed so as to prevent any undue ingress of air into the food storage compartment(s) (or cabinets).

4.7 Refrigerating System

4.7.1 The mechanical operation of the appliance should not give rise to undue noise or vibration.

4.7.2 The design of the condenser should be such as to reduce to a minimum the accumulation of dust.

4.7.3 The evaporator shall be so designed or protected so that it will not suffer any damage during the normal use of the appliance.

The heat exchange surfaces shall be made of corrosion-resistant material, or shall be finished with a corrosion-proof non-poisonous coating resistant to temperature changes and alternating frosting and defrosting.

4.7.4 The means of adjustment of temperature control devices, if intended to be adjusted by the user, should be readily accessible, and their function shall be such as to enable the appliance to meet the requirements of the performance tests.

4.7.5 Pipes and connections to moving or resiliently mounted parts should be arranged so as not to generate noise, not to touch nor to transmit vibrations to other parts, and should be so designed as to prevent failure due to fatigue. All other pipes and connections should be securely anchored, where necessary.

4.7.6 Suitable means should be provided to prevent water condensed on cold parts from affecting the operation of the unit or its controls, or from causing any other damage to the appliance and its surroundings.

4.8 Range of Voltage

The appliances shall at least be capable of operation within ±10 percent of the rated voltage.

5 REQUIRED CHARACTERISTICS

5.1 Volumes and Areas

5.1.1 *Rated Gross Volume*

The measured gross volume shall not be less than the rated gross volume by more than 3 percent of the latter or 1 litre, whichever is the greater value.

5.1.2 *Rated Storage Volume*

The measured storage volume shall not be less than the rated storage volume by more than 3 percent of the latter or 1 litre, whichever is the greater value.

5.1.3 *Rated Cellar Compartment Storage Volume*

The rated storage volume of any cellar compartment shall not be greater than the rated storage volume of the fresh food storage compartment. Where the volumes of the cellar compartment and fresh food storage compartment are adjustable relative to one another by the user, this requirement shall apply when the cellar compartment is adjusted to its minimum volume.

5.1.4 *Rated Storage Shelf Area*

The measured storage shelf area, including that of any cellar and chill compartment, shall not be less than the rated storage shelf area by more than 3 percent of the latter.

5.2 Performance Characteristics

5.2.1 *Storage Temperatures*

Under the conditions specified in **12** the appliance shall be capable of maintaining simultaneously the required storage temperature in different compartments as laid down in Table 1.

5.2.2 *Pull-Down Temperature Test*

5.2.2.1 The purpose of this test is to determine the pull-down capacity simultaneously in all sections/ compartments of the appliance when operated under no load condition.

5.2.2.2 The time required to pull-down the appliance to the temperatures specified in Table 1 shall not be more than the value stated by the manufacturer by more than 10 percent of the latter.

5.2.3 *Energy Consumption*

5.2.3.1 The energy consumption for refrigerators under test conditions as specified in **7** shall meet the minimum energy performance standards for the respective adjusted storage volumes as stipulated for the respective periods.

$$\text{Minimum Energy Performance Standard (MEPS)}_{nf} = k_{nf} \times V_{adj\_tot\_nf} + c_{nf}$$

where

k_{nf} = constant multiplier (kWh/litre/year),

$V_{adj\_tot\_nf}$ = total adjusted storage volume for no frost (litre), and

c_{nf} = constant fixed allowance (kWh/year).

Constant Multiplier and Constant Fixed Allowance for Frost-Free Refrigerators

Sl No.	*MEPS Period*	*Constant Multiplier* k_{nf}	*Constant Fixed Allowance* c_{nf}
(1)	(2)	(3)	(4)
i)	01 June 2006 - 31 December 2008	0.871 6	759
ii)	01 January 2009 - 31 December 2011	0.557 8	486
iii)	01 January 2012 - 31 December 2014	0.446 3	389

NOTE — Performance standards prescribed minimum efficiencies (or maximum energy consumptions) that manufacturers must achieve in each and every product, specifying the energy performance but not the technology or design detail of the product.

5.2.3.2 *Rated energy consumption*

If the energy consumption is stated by the manufacturer, the value measured in the energy consumption test on the first appliance tested shall not be greater than the rated energy consumption by more than 10 percent of the latter.

If the result of the test carried out on the first appliance is greater than the declared value plus 10 percent, the test shall be carried out on a further three appliances.

The arithmetical mean of the energy consumption values of these three appliances shall be equal to or less than the declared value plus 10 percent.

5.2.3.3 However the energy consumption shall not exceed the values specified in **5.2.3.1**.

5.2.4 *Ice-Making (if Applicable)*

If the ice-making capacity is stated by the manufacturer, the value measured in accordance with **17** shall not be less than the declared value by more than 10 percent of the latter. Similarly if the ice-making time is stated by the manufacturer, the time measured in accordance with **17** snall not be more than the declared time plus 10 percent of the latter.

If the ice-making capacity obtained from the first test is less than the declared value minus 10 percent, the test shall be carried out on a further three appliances.

The arithmetical mean of the ice-making capacity (or ice-making time) values of these three appliances shall not deviate by mcre than 10 percent.

5.2.5 *Temperature Rise Test (Informative)*

6 DETERMINATION OF LINEAR DIMENSIONS, VOLUMES AND AREAS

The measurements are carried out on the appliance as delivered and not operating. If there is a cellar compartment, the volume of which is adjustable, the measurements shall be made with this compartment adjusted to both its minimum and maximum volumes (*see* **5.1.3**).

6.1 Determination of Linear Dimensions

Linear dimensions shall be measured to the nearest millimetre.

6.2 Determination of Volumes

Volumes shall be expressed in a whole number of cubic decimetres or of litres.

6.2.1 *Determination of Gross Volume*

The gross volume shall be calculated by dividing the total volume into convenient units of volumes of geometric shapes, which can easily be measured. Other methods are also acceptable.

When the gross volume is determined, internal fittings such as shelves, removable partitions, containers, evaporators, thermostats and interior light housings shall be considered as not being in place. However, the gross volume shall take into account the exact shapes of the walls, if they contain depressions or projections (for example, *see* Fig. 3).

6.2.2 *Determination of the Total Storage Volume*

The total storage volume of the appliance shall be the sum of the storage volumes of the fresh food storage compartment(s), freezer compartment(s), cellar compartment(s), and chill compartment ice-making compartment.

For the determination of storage volumes, the total volume of devices and of spaces considered unusable for the storage of food shall be deducted from the gross volume calculated in accordance with **6.2.1** [*see* **6.2.3** for fresh food storage compartment(s) and cellar compartment(s), chill compartment(s) and **6.2.4** and **6.2.5** for low-temperature compartments (or cabinets) and food freezer compartment(s) (or cabinets), if applicable].

6.2.3 *Storage Volume of Fresh Food Storage Chill and Cellar Compartments (if Applicable)*

The storage volume of the fresh food storage, cellar and chill compartments shall be the gross volume of the compartment minus

a) volume of the evaporator space, as defined in **6.2.3.1**, if applicable;
b) volume of any housings (such as those for interior lights, thermostats and other devices);
c) volume of shelves, partitions, retainers and other accessories, whose wall thickness is greater than 13 mm, as defined in **6.2.7**; and
d) space between the inner door protrusion (dykes) and the inner liner of the fresh food storage, cellar and chill compartment.

Where the volumes of the cellar compartment and fresh food storage compartment are adjustable relative to one another by the user, the storage volumes of these compartments shall be determined with the cellar compartment adjusted to its minimum and maximum volumes.

6.2.3.1 *Volume of the evaporator space (if applicable)*

The volume of the evaporator space shall be the product of the depth, width and height, defined as follows.

6.2.3.1.1 *Depth*

The depth of the evaporator space shall be the mean horizontal distance between the front and rear surfaces of the enclosed space of the cabinet, measured at the level of the evaporator, unless there is a space provided in front of the evaporator for food storage.

Where a storage space is located in front of the evaporator, the depth of the evaporator space shall be taken as the mean horizontal distance from the inner surface of the rear of the enclosed space of the cabinet to the foremost part of the evaporator, or of the evaporator door if fitted.

6.2.3.1.2 *Width*

The width of the evaporator space shall be the overall horizontal width of the evaporator itself (neglecting suction headers near the top of the evaporator) or, if side ribs are used, the overall width including the ribs.

If there is less than 70 mm horizontal distance between the evaporator or the ribs and an inside wall of the enclosed space of the cabinet, such space shall be computed as pan of the evaporator space.

6.2.3.1.3 *Height*

The height of the evaporator space shall be the mean vertical distance between the lower limit of the evaporator and the upper partition of the food storage compartment.

If the free space between the upper surface or top of the evaporator and the upper partition of the food storage compartment exceeds 40 mm, it shall be added to the storage volume of the fresh food storage compartment. The evaporator height shall include any internal drip tray and/or drip collector.

6.2.4 *Storage Volume of Ice-Making Compartments*

The storage volume of the ice-making compartments shall be the sum of the volumes of all the compartments of this type in the refrigerating appliance.

The volumes of these compartments shall be determined in a similar manner to that specified in **6.2.2** and **6.2.3**, as appropriate.

6.2.5 *Storage Volume of Freezer Compartments (or Cabinets)*

For the determination of the storage volume of these compartments (or cabinets), the total volume which is unsuitable for storage shall be determined and then deducted from the gross volume determined as indicated in **6.2.3**.

The total volume to be deducted shall comprise (for example, *see* Fig. 3):

a) space occupied by the evaporator as defined in **6.2.3.1**;
b) incase an ice twister is provided the volume occupied by the shape of the mounting bracket;
c) volume of all fixed components inside the compartment which are not useful for storage;
d) volume of spaces which are to be kept free for the good performance of the refrigerating system like protrusion from plenum, etc;
e) volume occupied by the shelves and partitions whose thickness is greater than 13 mm (*see* **6.2.7.1**);
f) any volume where the vertical clearance is less than 25 mm;
g) volume rendered unusable by the use of removable parts (for example, basket, shelves) necessary for obtaining satisfactory thermal and mechanical characteristics.

6.2.7 *Volumes of Shelves and Partitions (for example,* see *Fig.* 4)

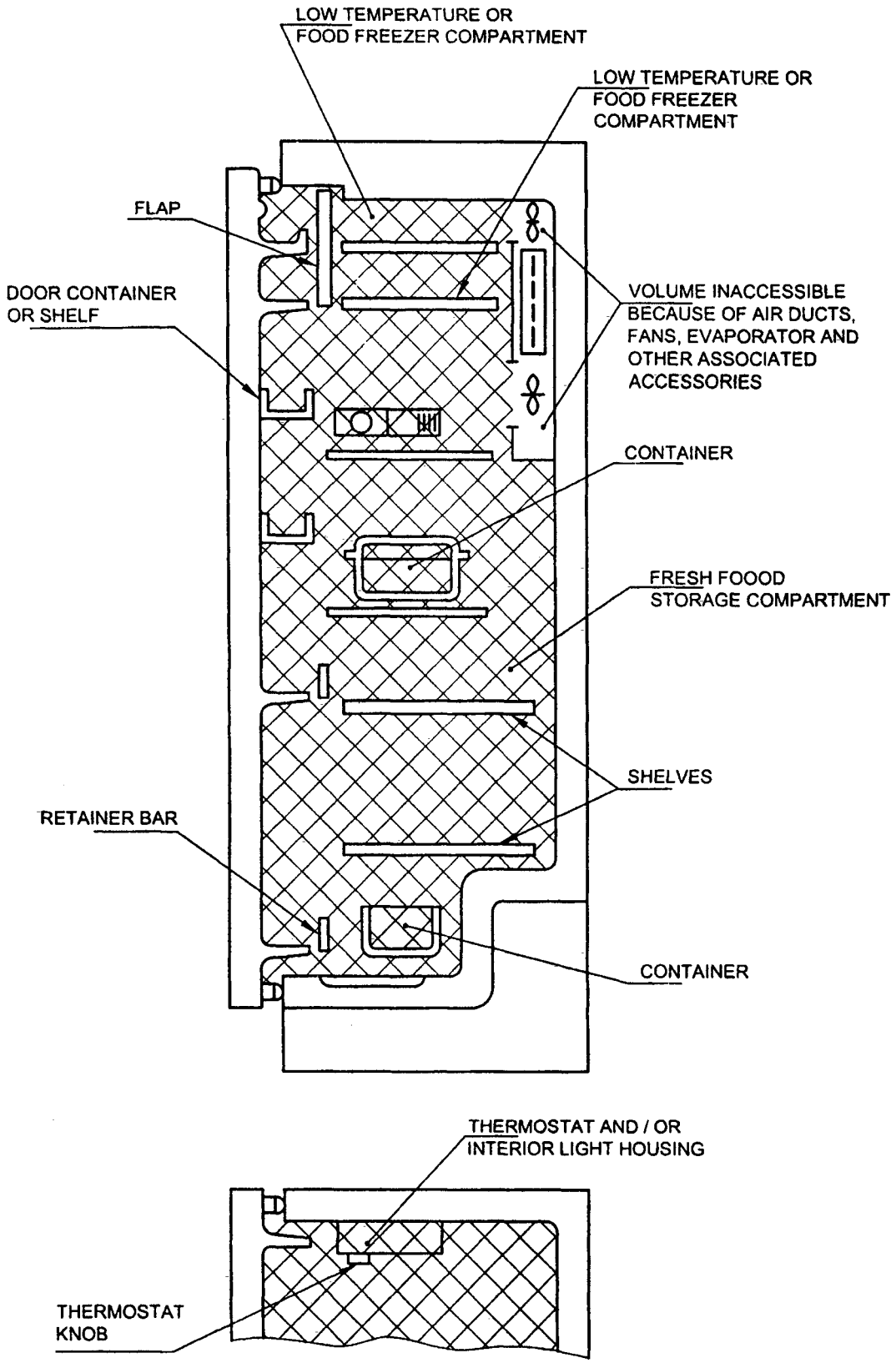
6.2.7.1 *Thickness*

The thickness of a shelf or partition shall be the mean distance between its outer surfaces.

Where the surface of a shelf or partition is corrugated or fitted with external pipe grids, the surface shall be the plane joining the outer apixes of the corrugations or pipes, unless the distance between adjacent corrugations or pipes is greater than 100 mm.

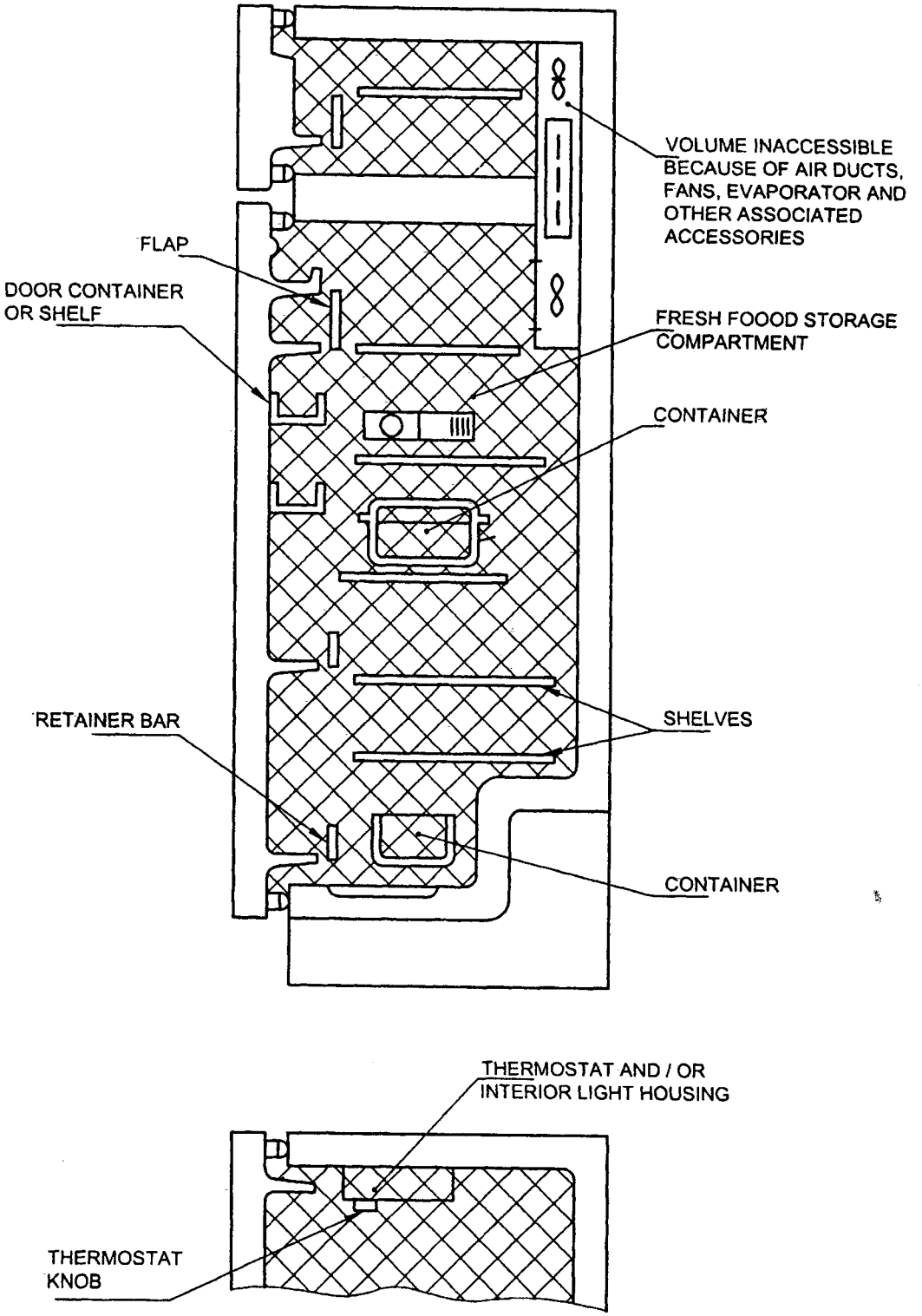
6.2.7.2 *Full shelves and partitions*

The volume of a full shelf or partition shall be the



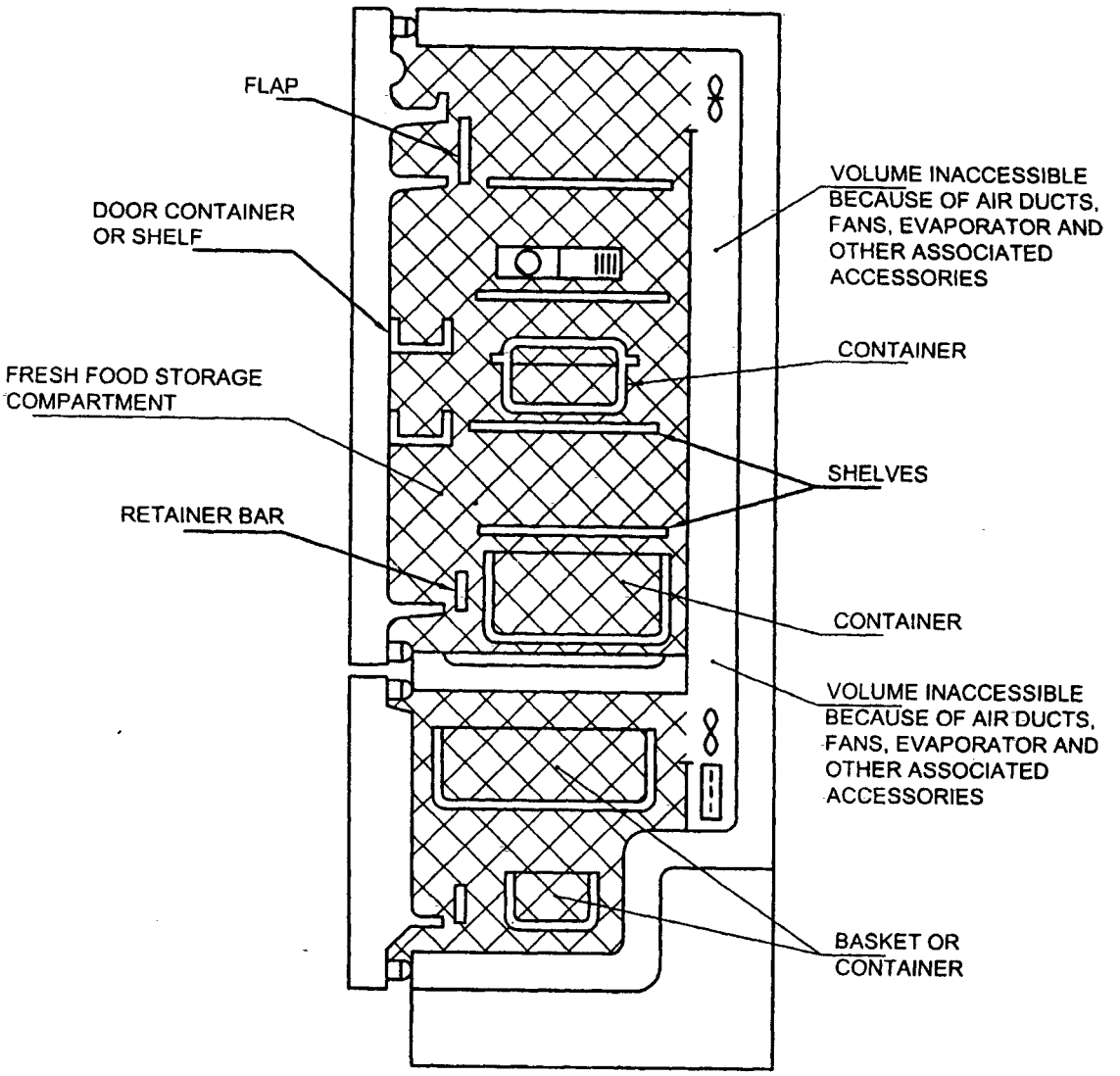
a) SINGLE DOOR REFRIGERATOR OR REFRIGERATOR - FREEZER

FIG. 3 EXAMPLES OF DETERMINATION OF GROSS VOLUME *(Continued)*



b) REFRIGERATOR FREEZER WITH TWO DOORS AND TOP FOOD FREEZER COMPARTMENT

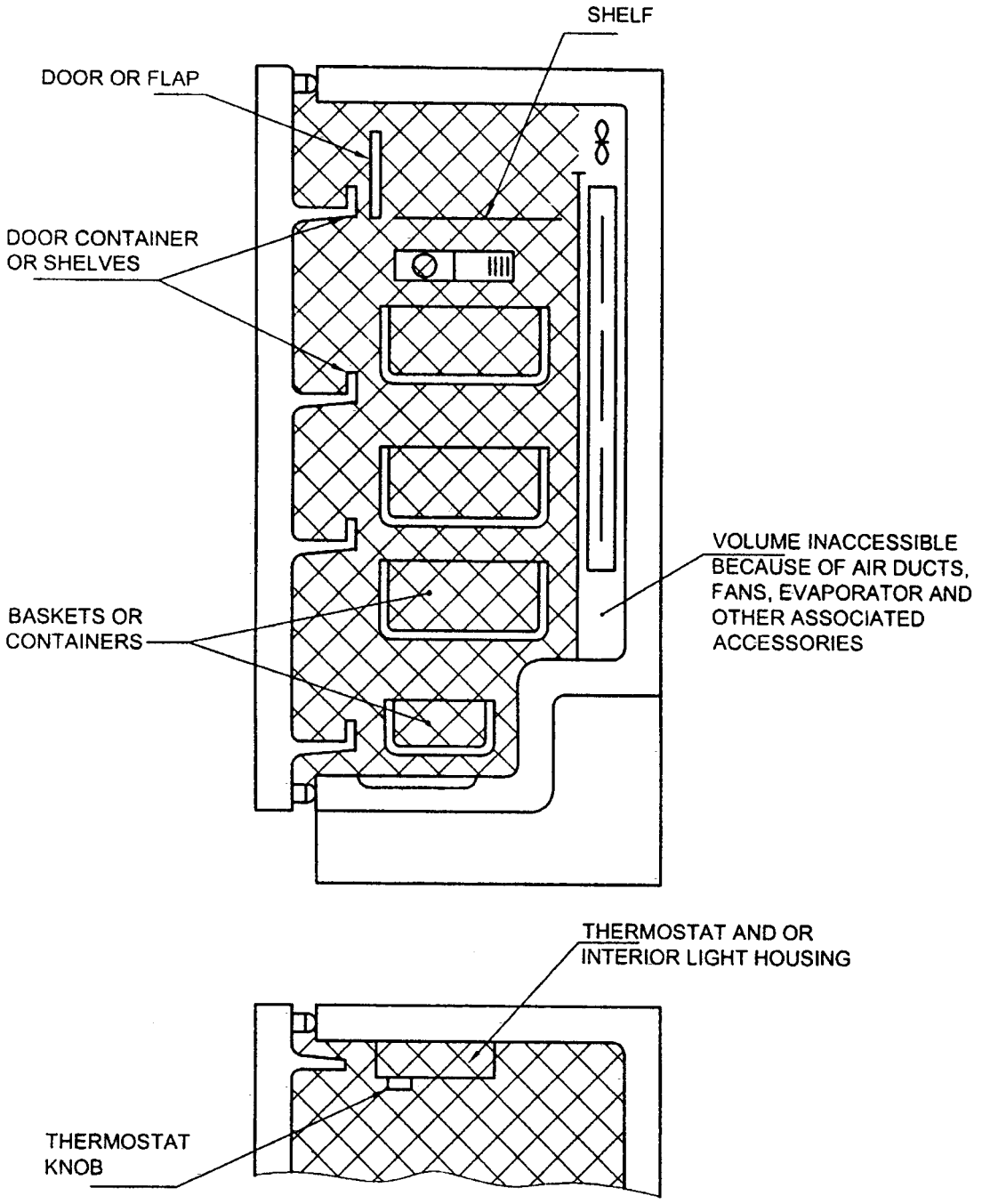
FIG. 3 EXAMPLES OF DETERMINATION OF GROSS VOLUME (*Continued*)



c) REFRIGERATOR FREEZER WITH TWO DOORS AND BOTTOM FOOD FREEZER COMPARTMENT

NOTE — The cross hatching shows the gross volume.

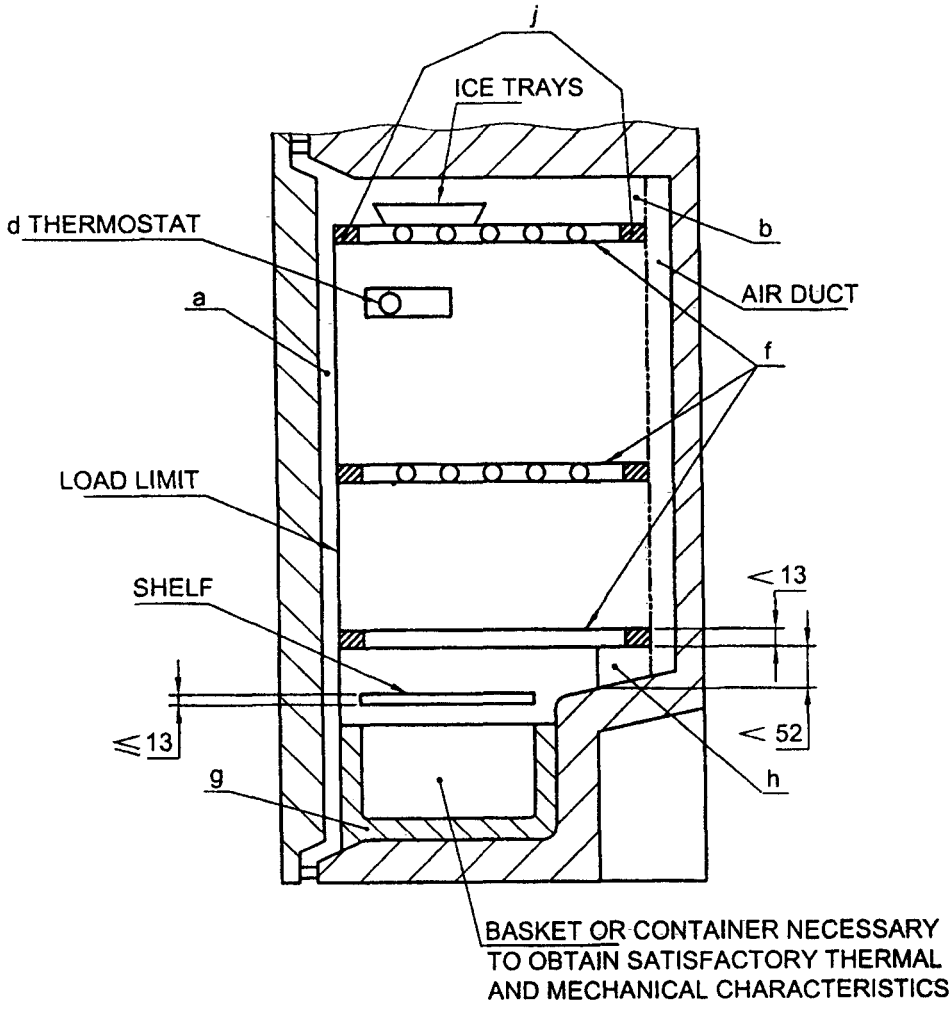
FIG. 3 EXAMPLES OF DETERMINATION OF GROSS VOLUME *(Continued)*



d) FROZEN FOOD STORAGE CABINET
OR FOOD FREEZER

NOTE — The cross hatching shows the gross volume.

FIG. 3 EXAMPLES OF DETERMINATION OF GROSS VOLUME



NOTE — The volumes marked *a*, *b*, *d*, *f*, *g*, *h* and *j* shall be deducted from the gross volume.

FIG. 4 EXAMPLES OF DETERMINATION OF STORAGE VOLUME OF FROZEN FOOD STORAGE OR FOOD FREEZER COMPARTMENTS (OR CABINETS)

product of its thickness and its depth, width or height whichever two of these are applicable. The depth, width and height shall be those dimensions of the enclosed space of the cabinet which apply in the plane of the shelf or partition.

6.2.7.3 *Fractional shelves and partitions (if applicable)*

The volume of a fractional shelf or partition shall be the product of its thickness and its depth, width or height, whichever two of these are applicable.

The depth, width or height shall be the distances from the adjacent surfaces of the enclosed space of the cabinet, and normal to those surfaces, to the further edges of the shelf or partition, or to the evaporator in cases where the fractional shelf or partition touches it, if applicable.

A horizontal shelf or partition, the edges of which are more than 70 mm from the surfaces of the enclosed space of the cabinet, shall be regarded as a fractional shelf or partition. A vertical partition, the edges of which are more than 100 mm from the surfaces of the enclosed space of the cabinet, shall be regarded as a fractional partition.

6.3 Determination of Storage Shelf Area

The area shall be expressed, in square decimetres.

6.3.1 *Determination of the Area of Shelves*

6.3.1.1 *Full shelves composed of a single part*

In the case of a full shelf composed of a single part, the area shall be the product of the width and depth. These two dimensions shall be determined as follows:

a) *Width*; mean distance measured parallel to the surface of the shelf between the inner surfaces

of the side walls of the enclosed space of the cabinet, where this dimension does not exceed the actual width of the shelf by more than 20 mm [*see* Fig. 5(a)].

b) *Depth*; mean distance measured parallel to the surface of the shelf (or of the bottom of the appliance) between the inner surfaces of the front and rear walls of the enclosed space of the cabinet, where this dimension does not exceed the actual depth of the shelf by more than 20 mm [*see* Fig. 5(b)]. When the door of an upright-type appliance is provided with shelves, this distance shall be determined by analogy [*see* Fig. 5(c) and 5(d)].

6.3.1.2 *Fractional shelves*

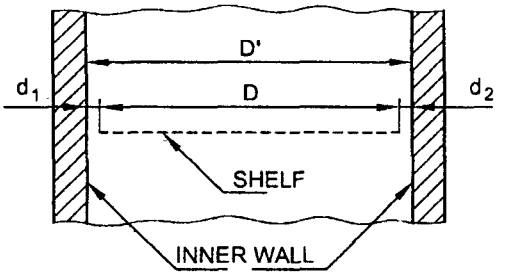
For the purpose of calculating the area of fractional shelves, the width and depth shall be measured parallel to the surface of the shelves in a similar way to that for full shelves (*see* **6.3.1.1**) but taking into account Fig. 5(e).

6.3.1.3 *Cut-away shelves*

When a shelf is cut away, the area of the portion cut out shall be deducted.

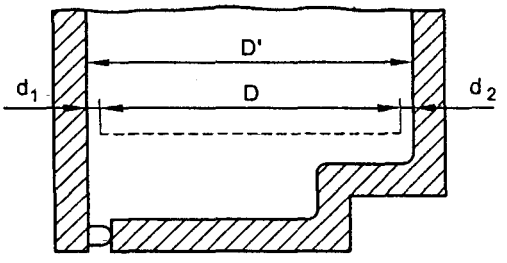
6.3.1.4 *Juxtaposed shelves*

In the case of juxtaposed shelves, the depth shall be determined in accordance with Fig. 5(d).



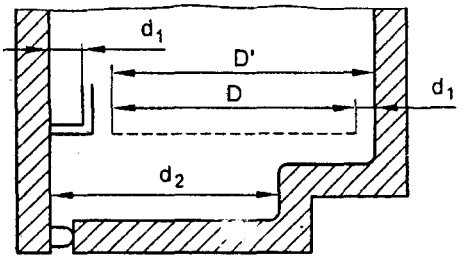
IF $d_1 + d_2 \leq 20$
DIMENSION OF THE SHELF = D'
IF $d_1 + d_2 > 20$
DIMENSION OF THE SHELF = D

a) DETERMINATION OF WIDTH



IF $d_1 + d_2 \leq 20$
DIMENSION OF THE SHELF = D'
IF $d_1 + d_2 > 20$
DIMENSION OF THE SHELF = D

b) DETERMINATION OF DEPTH - UPRIGHT TYPE APPLIANCE WITHOUT STORAGE IN THE DOOR

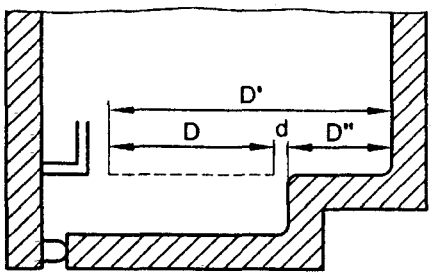


IF $d_1 \leq 20$
DIMENSION OF THE SHELF = D'
IF $d_1 > 20$
DIMENSION OF THE SHELF = D
DIMENSION OF THE DOOR SHELF = D_1
DIMENSION OF THE BOTTOM OF THE APPLIANCE = D_2

c) DETERMINATION OF DEPTH - UPRIGHT TYPE APPLIANCE WITH STORAGE IN THE DOOR

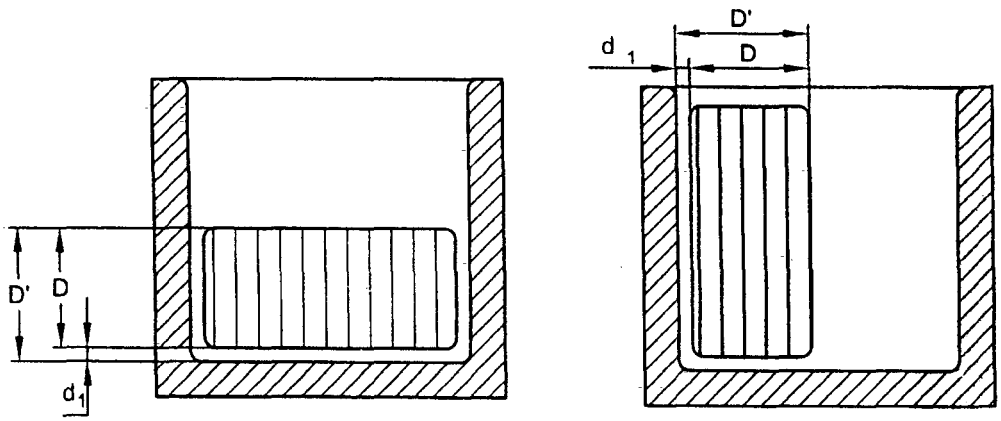
All dimensions in millimetres.

FIG. 5 EXAMPLES OF DETERMINATION OF DIMENSIONS FOR CALCULATING THE AREA OF SHELF (*Continued*)



IF $d_1 \leqslant 20$
DIMENSION OF THE SHELF = D'
IF $d > 20$
2 SHELVES OF DIMENSIONS D AND D"

d) DETERMINATION OF DEPTH SHELF WITH JUXTAPOSED PARTS



IF $d_1 \leqslant 20$ mm
DIMENSION OF THE SHELF = D'
IF $d_1 > 20$ mm
DIMENSION OF THE SHELF = D

e) DETERMINATION OF THE DIMENSIONS OF FRACTIONAL SHELVES

All dimensions in millimetres.

FIG. 5 EXAMPLES OF DETERMINATION OF DIMENSIONS FOR CALCULATING THE AREA OF SHELF

6.3.1.5 *Door shelves*

The area shall be the product of the width and depth. These two dimensions shall be determined by analogy with **6.3.1.1**, as follows:

a) *Width*; mean distance between the inner surfaces of the side walls of the door compartment or between the side edges of the retainer bar.

b) *Depth*; mean distance between the surface of the door wall and the vertical plane tangential to the inner front surface of the shelf or retainer bar [*see* Fig. 5(c)].

6.3.1.6 *Baskets and containers*

The area shall be the product of the two mean horizontal dimensions [*see* Fig. 6(a)].

6.3.1.7 *Particular cases*

6.3.1.7.1 *General*

The bottom of the enclosed space of the cabinet shall be considered as a shelf.

When an inner wall is not vertical, the dimension of the shelf shall be measured at the mid-height between the shelf under consideration and the shelf or horizontal surface immediately above.

6.3.1.7.2 *Fresh food storage compartment and chill cellar compartment, if any*

Any part of full shelves, baskets or of the bottom of a compartment having less than 100 mm vertical clearance above, when all the shelves and baskets are in position, shall be excluded when calculating the storage area. However, it is admissible that for one full

shelf or basket the vertical clearance may be reduced to not less than 80 mm [*see* Fig. 6(b)].

6.3.1.7.3 *Food freezer compartments (or cabinets) and low-temperature compartments (or cabinets)*

Any part of full shelves, baskets or of the bottom of a food freezer compartment (or cabinet) or frozen food storage compartment (or cabinet) having less than 52 mm vertical clearance above, when all the shelves and baskets are in position, shall be excluded when calculating the storage area [*see* Fig. 6(b)].

In the case of an ice-making compartment, the minimum vertical clearance shall not be less than 40 mm.

6.3.2 *Drip Tray*

The drip tray shall not be considered as a food shelf area.

6.3.3 *Suspended Containers*

6.3.3.1 *Fresh food storage compartment chill and cellar compartment, if any*

The area of the interior surface of the bottom of a suspended container and the area of the shelf immediately below shall not both be counted unless the vertical clearance between this shelf and the exterior surface of the bottom of the container is at least 100 mm.

Nevertheless, in the case of one container (and one only), this minimum clearance may be reduced to 80 mm to the extent where this possibility has not been applied for the shelves.

If the minimum vertical clearance within a suspended container, as measured between the interior surface of the bottom and the cover, or to the shelf immediately above, is less than 40 mm, the bottom area of the container shall not be added.

6.3.3.2 *Food freezer compartments (or cabinets) and low-temperature compartments (or cabinets)*

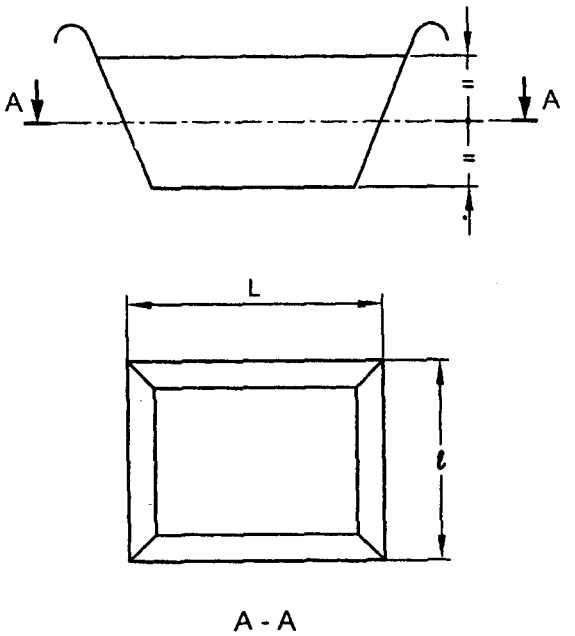
For a food freezer compartment (or cabinet) or frozen food storage compartment (or cabinet), the dimension of the minimum vertical clearances specified in **6.3.3.1** is 52 mm in all cases.

For an ice-making compartment, the minimum vertical clearance dimension is 40 mm in all cases.

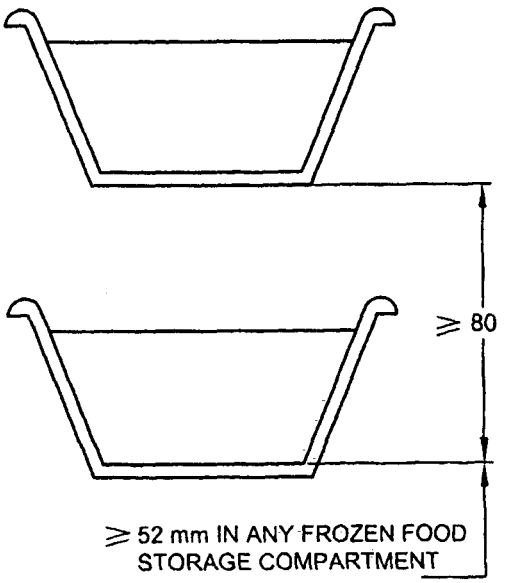
7 GENERAL TEST CONDITIONS

The order of carrying out the tests need not necessarily follow the sequence of the tests given in this standard.

The results of the tests shall appear in a test report. When necessary, particular information to be noted in this report is mentioned as a special item of the sub-clause concerning the test.



a) AREA OF BASKET



b) VERTICAL CLEARANCE ABOVE A BASKET

All dimensions in millimetres.

FIG. 6 EXAMPLES OF DETERMINATION OF MEAN DIMENSIONS FOR CALCULATING THE AREA OF A BASKET

7.1 Test Room

The appliance shall be set up in a test room as specified in **7.1.3**.

7.1.1 *Ambient Temperature*

Tests shall be carried out under the following conditions of ambient temperature:

a) for no load pull down +43°C; and
b) for checking the energy consumption, temperature rise time and food freezing capacity of all appliances, as applicable +32°C.

The temperature at each measurement point (*see* **3.4.10**) shall be kept constant within ±0.5 K of the nominal ambient temperature both during the periods required for obtaining stable operating conditions and during the tests.

The vertical ambient temperature gradient from the platform specified in **7.1.3** to a height of 2 m shall not exceed 1 k/m.

7.1.2 *Humidity*

Unless otherwise specified, relative humidity shall be kept between 45 percent and 75 percent.

7.1.3 *Installation of Appliances*

Each appliance shall be placed on a wooden solid-top platform, painted dull black and open for free air circulation under the platform. The top of the platform shall be 0.3 m above the test room floor and shall extend at least 0.3 m, but not more than 0.6 m, beyond all sides of the appliance, except at the rear where it shall extend to the vertical partition.

Circulation of air about the appliance shall be restricted by surrounding the appliance by three vertical partitions made of wood 16 to 30 mm thick, painted dull black, arranged as follows:

a) One of the partitions shall be placed parallel to the rear of the appliance, against the stops or at the distance specified by the manufacturer in connection with the required overall space. At the rear of this partition there shall be sufficient air gap to the room wall (as per manufacturer recommendation but not more than 50 mm) to minimize the influence of adjacent structure.
b) The two other partitions shall be parallel to the sides of the cabinet, and shall be fixed on the platform 0.3 m from the sides of the cabinet; they shall be 0.3 m wide.
c) The whole partition structure shall have the form and dimensions shown in Fig. 7.

The vertical partition structure shall present no discontinuity. They shall be of such a height that they extend at least 0.3 m above the top of the appliances.

The appliance shall be so placed or shielded as to prevent direct radiation to or from the space cooling or heating equipment in the test room, and shall be placed far enough away from all other objects in the test room to eliminate any possibility of any point in the space in which it is situated being at a temperature other than ambient.

Air circulation in the test room shall be such that the specified ambient temperatures are obtained within the limits of the specified tolerances. The appliance under test shall be shielded from any air currents of velocity above 0.25 m/s.

The air circulation in the test room shall not interfere with the normal air circulation created by the appliance.

If the surface temperature of the floor of the test room, measured by thermocouples at points vertically below the ambient temperature measuring points, is within 1.5 K of the specified ambient temperature, the appliance may be placed directly on the floor.

Appliances intended to be built-in shall be built in accordance to the manufacturer's instructions.

Built-in appliances intended to be combined with appliances other than refrigerating appliances shall be subjected to the tests while they are combined, but with the other appliance not functioning.

7.2 Operating Requirements for the Appliance

7.2.1 *Thermostat Setting*

The thermostat setting requirements are specified for each test.

When the appliance is fitted with a thermostat which is not designed for adjustment by the user, the appliance shall be tested in the condition as delivered.

7.2.2 *Anti-condensation Heaters*

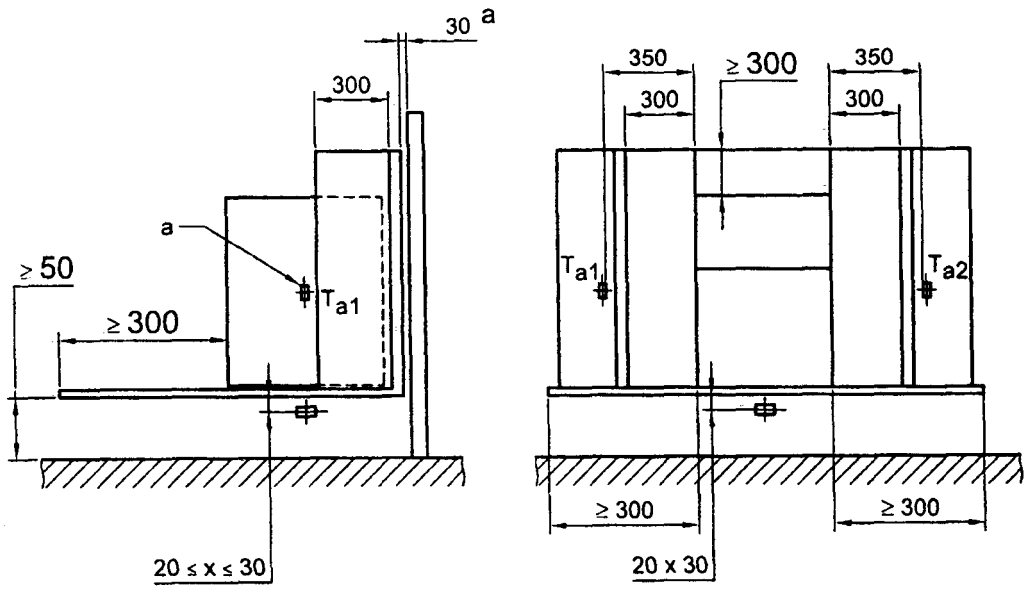
If an appliance is fitted with an anti-condensation heater which can be switched on and off by the user, this shall be switched on except for the energy-consumption test, when it shall be switched on only if it is needed to withstand the water vapour condensation test. If adjustable, it shall be set at maximum heating.

7.2.3 *Electric Power Supply*

The appliance shall be tested at the rated voltage and frequency, or at the mean of the rated voltage range ±1 percent.

7.2.4 *General Conditions for the Use of Baskets, Containers, and Shelves and Trays*

All shelves, and only those baskets, containers and trays



All dimensions in millimetres.

a — distance to wall of test room > 30 mm. Air velocity measurement < 0.25 m/s at centre of all accessible appliance walls (also top) 300 mm distance.

FIG. 7 PARTITION TO RESTRICT AIR CIRCULATION AND AMBIENT TEMPERATURE SENSOR POSITION

which have been taken into consideration when determining the storage volume, shall be in position.

7.3 Measuring Instruments

Temperatures shall be measured with temperature probes, the sensors of which are inserted in the centre of tin-covered solid copper or brass cylinders having a mass of 25 g and of minimum external area (diameter = height = about 15.2 mm) for measuring the internal temperatures (for all performance tests) or for measuring the ambient temperature. The temperatures shall be recorded. Temperature-measuring instruments shall be accurate to within ±0.3 K.

The relative humidity shall be measured and recorded at a point which is representative. The accuracy of the measuring instruments shall be such that the result, expressed as the dew point, is accurate to within ±0.3 K.

Watt-hour meters shall be readable to 0.01 kWh and be accurate to within ±1 percent. The measuring accuracy shall be stated in the test report.

7.4 Measurement of the Temperature of the Fresh Food Storage Compartment and Cellar Compartment and Chill Compartment (if Applicable)

The temperatures t_1, t_2, t_3 (*see* **3.4.3.1**) and t_{c1}, t_{c2}, t_{c3} shall be measured as specified in the particular test procedure, tin covered copper or brass cylinders suspended with the circular surface horizontal, the temperature-sensing points T_1, T_2, T_3 and T_{c1}, T_{c2}, T_{c3} being located at the places shown in Fig. 8 halfway between the rear internal wall of the appliance and the internal wall of the closed door.

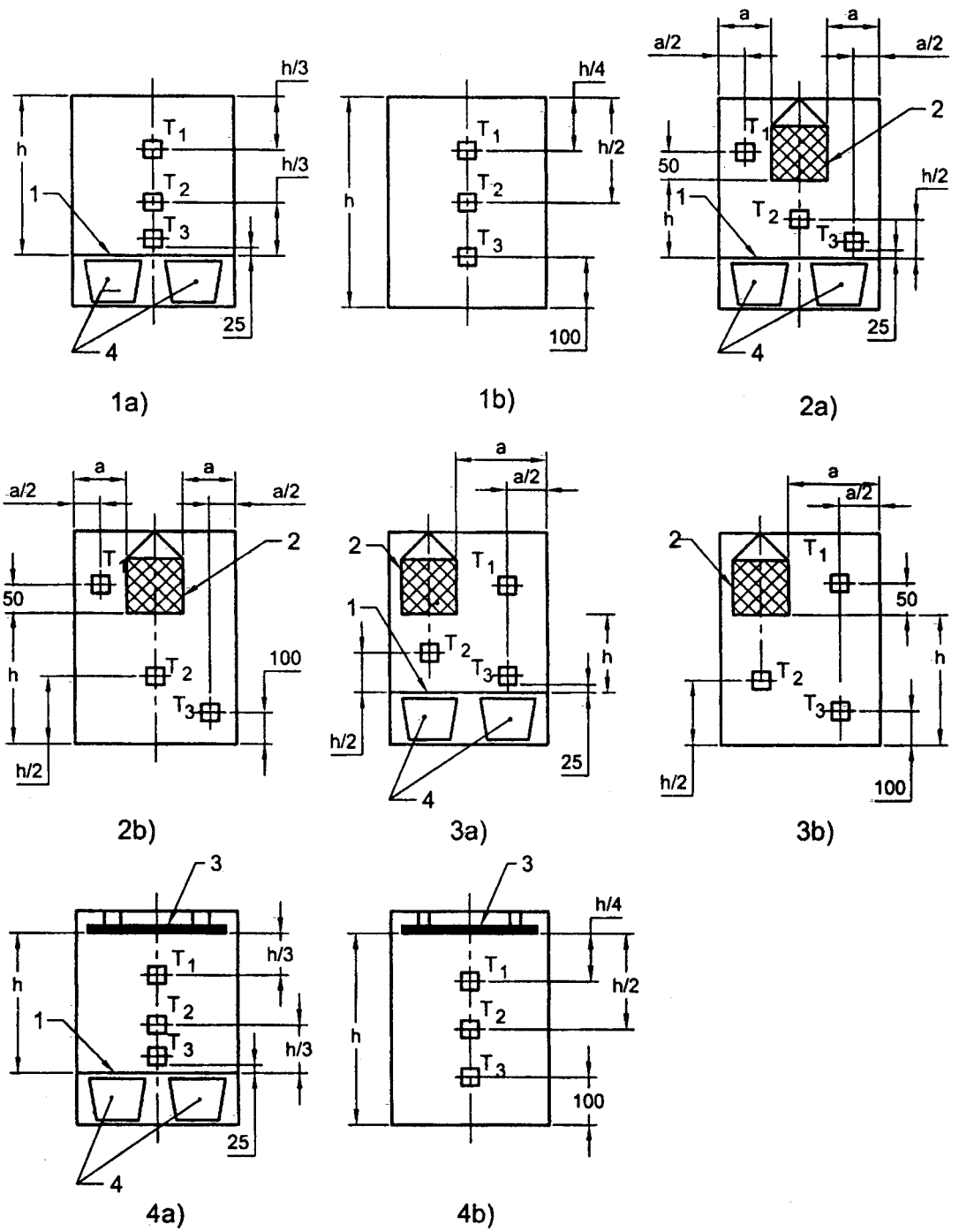
In chill compartments temperature measuring cylinders shall be placed where the highest and lowest temperatures are expected.

The means of suspension shall have the smallest possible cross-section and the lowest possible thermal conductivity, arranged in such a way that they do not significantly interfere with the normal air circulation.

If internal components do not allow the temperatures t_1, t_2, t_3 and t_{c2}, t_{c2}, t_{c3} to be read at the points specified, readings may be taken in positions such that one of the surfaces of the tin covered copper or brass cylinders is not more than 25 mm from the point specified. If the interior arrangement of the fresh food storage compartment and cellar compartment does not conform to those shown in Fig. 8, the temperatures t_1, t_2, t_3 and t_{c2}, t_{c2}, t_{c3} shall be read in positions determined by analogy with the positions indicated.

The temperatures shall be recorded. The tin covered copper or brass cylinders shall be separated from any heat conducting surface by at least 25 mm of air space. Connections from the measuring instruments shall be arranged in such a manner as not to interfere with the air seal of the food storage compartment.

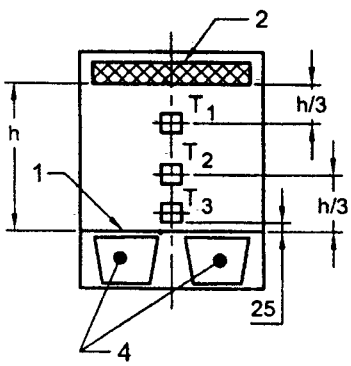
The compartment temperature is to be declared as the mean of above values (t_1, t_2 and t_3).



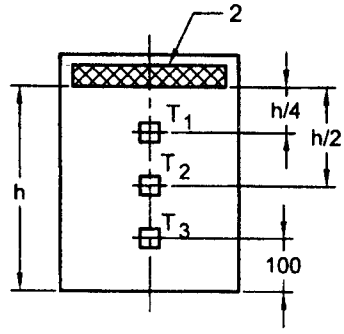
FOR ARRANGEMENTS 2a, 2b, 3a, & 3b: a ≥ 150

All dimensions in millimetres.

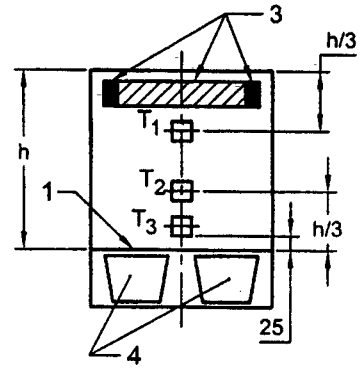
FIG. 8 TEMPERATURE SENSORS FOR MEASURING FRESH FOOD REFRIGERATOR COMPARTMENT (*Continued*)



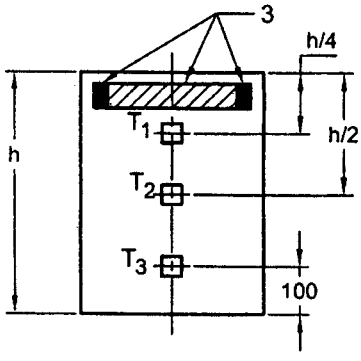
5a)



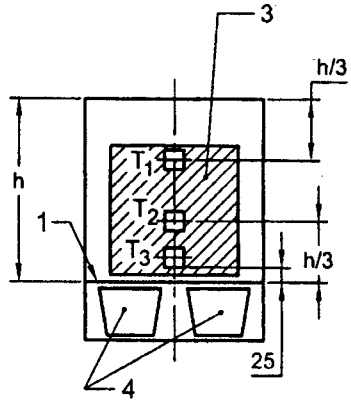
5b)



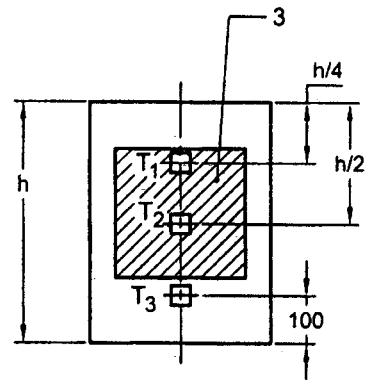
6a)



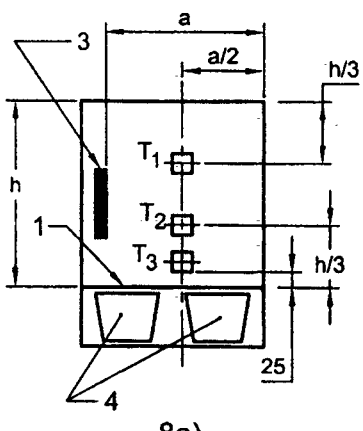
6b)



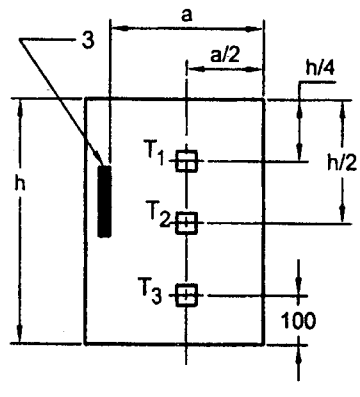
7a)



7b)



8a)



8b)

KEY

1 — shelf above vegetable container at lowest possible position
2 — box evaporator
3 — plate evaporator
4 — vegetable container

All dimensions in millimetres.

FIG. 8 TEMPERATURE SENSORS FOR MEASURING FRESH FOOD REFRIGERATOR COMPARTMENT (*Continued*)

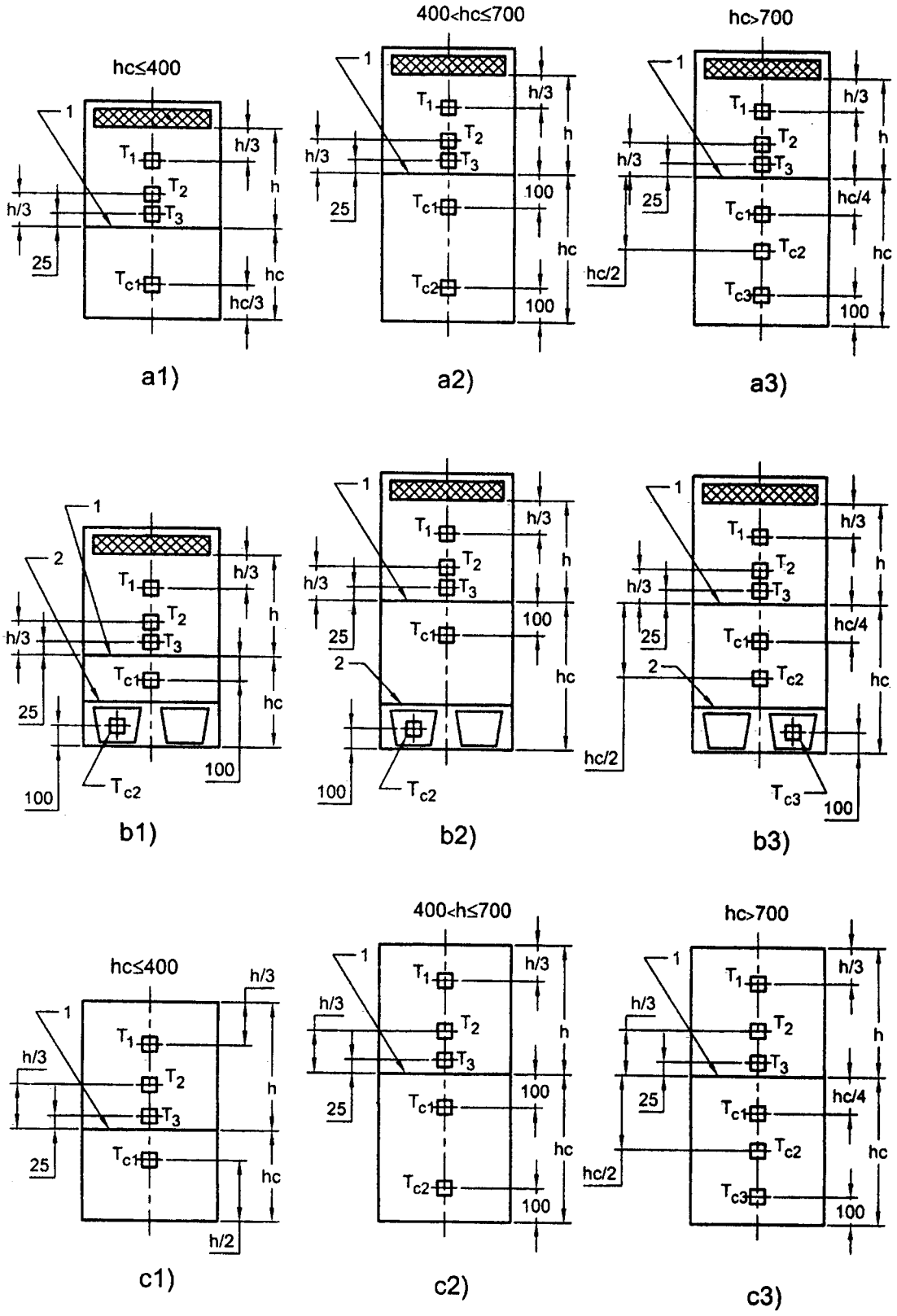


FIG. 8 TEMPERATURE SENSORS FOR MEASURING FRESH FOOD REFRIGERATOR COMPARTMENT

7.5 Measurement of the Temperature of Freezer Compartments (or Cabinets)

The temperatures shall be measured by sensors, which are placed at locations as indicated in Fig. 9.

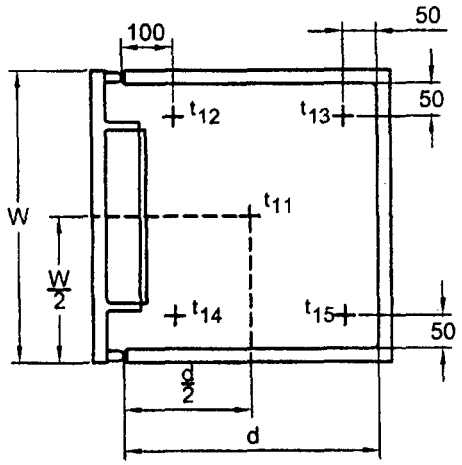
7.6 Test Period

The test period shall start at least 24 h after stable operating conditions have been attained. The test period shall start at the beginning of an operating cycle; shall be of at least 24 h duration and shall comprise a whole number of operating cycles. If an operating cycle starts but is not completed during the 24 h period, the test shall continue until the end of that operating cycle.

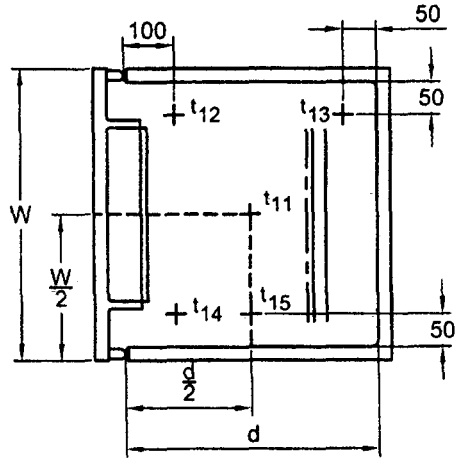
If one operating cycle is not completed during a 72 h period, the test period shall be terminated at the end of 72 h.

8 TESTING THE AIR TIGHTNESS OF DOOR OR LID SEAL(S)

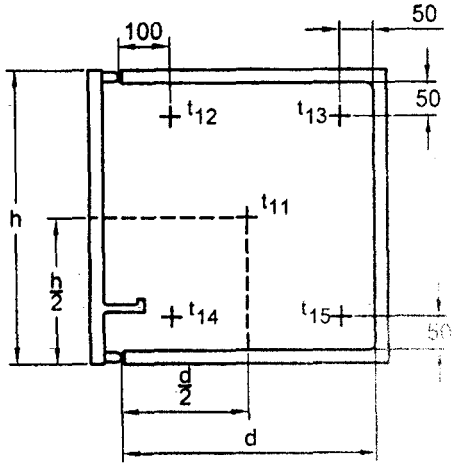
The purpose of this test is to ensure that the gasket(s) of the door(s) or lid(s) of the appliance adequately prevent(s) any abnormal ingress of the surrounding air.



TOP VIEW

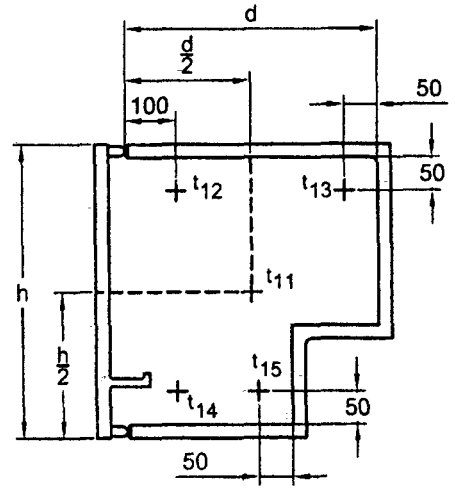


TOP VIEW



SIDE VIEW

a) TYPE 1



SIDE VIEW

b) TYPE 2

All dimensions in millimetres.

FIG. 9 LOCATION OF TEMPERATURE SENSOR WITH UPRIGHT FROZEN FOOD COMPARTMENTS WITH NO SHELVES

8.1 Procedure

The ambient temperature shall be between +16°C and +43°C. The appliance shall be switched off and shall be in equilibrium with the ambient temperature before carrying out the test.

A strip of paper 50 mm wide and 0.08 mm thick and of suitable length shall be inserted at any point of the seal, and the door or lid shall be closed normally on it. The verification of the thickness of the paper used shall be in accordance with IS 1060 (Part 1).

The seal shall be assessed by checking that the strip of paper does not slide freely.

The most unfavourable points may be found by inspecting the area around the seal with the appliance closed and illuminated from the inside.

This test shall be carried out both before and after the mechanical durability test (*see* **10**).

8.2 Test Report

The test report shall indicate whether the tightness of the door or lid seal(s) meets the requirements of **4.3**.

9 TESTING THE OPENING FORCE OF DOOR(S) OR LID(S)

The purpose of this test is to check that the door(s) or lid(s) can be opened from the inside. Compliance shall be checked by inspection and by the following test.

9.1 Procedure

The ambient temperature shall be between +16°C and +43°C. The appliance shall be switched off and be in equilibrium with the ambient temperature. The door or lid shall be closed for a period of 1 h, after which an 'opening' test shall be carried out under the following conditions:

The opening force of 70 N shall be considered as being applied to the inside of the door or lid of the appliance at the midpoint of the edge furthest from the hinge axis in a direction perpendicular to the plane of the door or lid.

The method of measurement shall be one of the following:

a) by applying the force at a point on the outer surface of the door or lid corresponding to the internal measuring point (for example, with the aid of a suction pad); and

b) if the handle of the door or lid is at the midpoint of the edge farthest from the hinge axis, by applying a force to the handle, the value of the force required to open the door or lid from the inside being determined by proportional calculation from the distances of the handle and of the internal measuring point from the hinge axis.

This test shall be carried out both before and after the mechanical durability test (*see* **10**).

9.2 Test Report

The test report shall indicate whether the opening force of the door(s) or lid(s) meets the requirements of **4.4**.

10 TESTING THE DURABILITY OF HINGES AND HANDLES OF DOOR(S) AND LID(S)

The purpose of this test is to check the durability of the hinges and handles of door(s) and lid(s).

10.1 External Door(s)

10.1.1 *Procedure*

The ambient temperature shall be between +16°C and +43°C.

The appliance shall be switched off.

The inner door(s) shall be loaded as specified in **11.1.2**.

The door shall be opened at least 45° from the cabinet reference wall before it starts closing. The number of cycles per minute shall be 10 to 20.

10.1.1.1 *Opening sequence* (*see* Fig. 10)

The movement of the door shall be controlled from an angle of 0° to an angle of opening between 5° and 15°, followed by a free movement of the door, the controlled movement being approximately sinusoidal. The opening of the door shall take place in the first quarter of the period of the cycle.

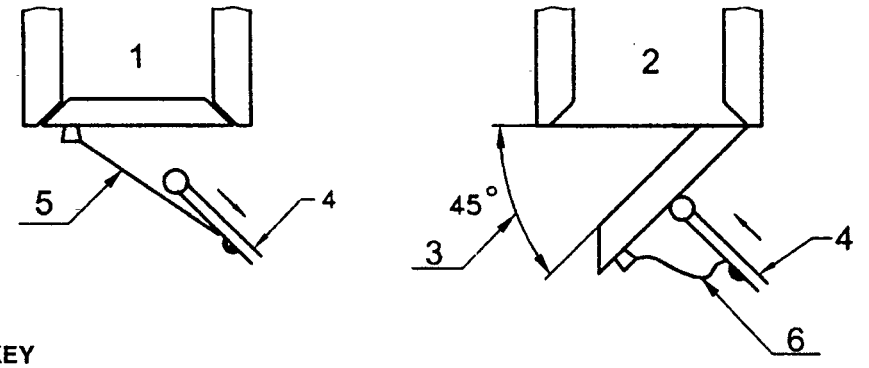
10.1.1.2 *Closing sequence* (*see* Fig. 10)

The movement of the door shall be controlled from the angle of opening of 45° to an angle between 40° and 35°, followed by the free movement of the door and its closing as in normal use.

The number of cycles per minute shall be 20 to 25.

a) For compartments with an internal temperature $T \geq -6°C$, external doors and lids shall withstand 100 000 opening and closing operations without deterioration which could be prejudicial to the air tightness of the door or lid.

b) For compartments with an internal temperature $T \leq -6°C$, external doors and lids shall withstand 30 000 opening and closing operations without deterioration which could be prejudicial to the air tightness of the door or lid.



KEY

1 — door opening
2 — door closing
3 — angle of opening
4 — pusher
5 — taut cable
6 — slack cable

FIG. 10 EXAMPLE OF OPENING AND CLOSING OF EXTERNAL DOORS

10.2 Test Report

The test report shall indicate whether the hinges and handles meet the requirements of **4.4** and whether the seals meet the requirements of **4.3**.

11 TESTING THE MECHANICAL STRENGTH OF SHELVES AND SIMILAR COMPONENTS

The purpose of this test is to check the mechanical strength of the components used for storing food (shelves, containers).

11.1 Procedure

The ambient temperature shall be between +16°C and +43°C.

11.1.1 *Food Freezer Compartment (or Cabinet), Frozen Food Storage Cabinet and Low Temperature Compartments (if Applicable)*

After the storage temperature test (*see* **12**), and with the appliance switched off, the behaviour of all loaded shelves, baskets and containers and their supports shall be examined.

All sliding or revolving shelves and containers shall be moved, without modification of their load, to the halfway position, *A*/2, of their permissible course (*see* Fig. 11), except that if stops are provided which limit the movement to less than the half-way position the components shall be moved to their stop. They shall be left in this position for 1 h and then returned to their initial position.

If the manufacturer has stated in the instructions for use that some shelves or containers slide out for maintenance or transportation, but must remain in a definite position in normal use, they shall be considered as fixed and the checking shall be carried out in the position as for the storage temperature test.

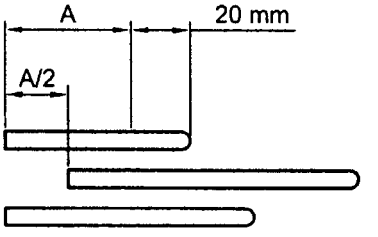


FIG. 11 TEST POSITION FOR SLIDING COMPONENTS WHICH HAVE NO LIMITING STOP

11.1.2 *Fresh Food Storage, Chill and Cellar Compartments (if Applicable)*

The appliance shall be switched off, with the door(s) open.

The components to be tested shall be loaded in turn with 80 mm diameter cylindrical weights of 1 000 g, but of only 500 g in the case of components above which the clear height in normal service cannot exceed 150 mm. Components which are specially designed to hold eggs shall not be loaded.

The weights shall be placed with their axes vertical and in such a way that the maximum possible number is accommodated without one weight being placed over another and without overlapping the edge of the component under test.

In the case of door shelves, the diameter of the weights may be changed, if necessary, to adapt them to the shape of the shelves, provided the load per unit area is the same.

The applied loads shall remain in position for 1 h.

11.2 Test Report

The test report shall indicate whether the shelves and containers for storing food meet the requirements of **4.5**.

12 TESTING THE STORAGE TEMPERATURES

The purpose of this test is to check compliance with the requirements of **5.2.1** at each of the ambient temperatures (*see* **7.1.1**).

12.1 Procedure

12.1.1 *Preparation of the Appliance*

The appliance shall be installed in the test room in accordance with **7.1.3**. The evaporator(s) shall be defrosted, if necessary, and the internal walls and components of the appliance dried. The means of access (doors or lids) shall be kept closed during the tests.

The appliance shall be set up as in service in accordance with the manufacturer's instructions. All internal fittings supplied with the appliance, including ice trays, shall be put in position, except that the ice trays shall be removed in the case of a food freezer compartment (or cabinet) or frozen food storage compartment (or cabinet) having no specific subdivision to accommodate such trays. If the appliance has thermostat(s) and/or other temperature-control device(s) which is (are) designed for adjustment by the user, the thermostat(s) and/or device(s) shall be set at the manufacturer's recommended position(s) for normal operation at the ambient temperature. When the thermostat(s) and/or device(s) is (are) not designed for adjustment by the user, the measurement shall be carried out on the appliance as delivered. The empty appliance shall be operated for at least 12 h or upto 24 h to reach equilibrium.

If the chill compartment has thermostat(s) and/or other control device(s) which is/are designed for adjustment by the user, the thermostat(s) and/or device(s) shall be set at the manufacturer's recommended position(s) for normal operation at the ambient temperature. Different re-adjustment may be allowed when required to compensate for different ambient temperatures and/or different operating conditions of the other compartments during the tests specified in **12, 16** and **17**.

12.1.2 *Appliances with Adjustable Cellar Compartment*

If the appliance includes a cellar compartment and the volumes of this compartment and of the fresh food storage compartment can be changed in relation to one another by the user, the cellar compartment shall be adjusted to its minimum volume for the test in high ambient temperature and to its maximum volume for the test in low ambient temperature (*see* **7.1.1**).

12.1.3 *Measurements*

For the appropriate ambient temperature, the thermostat(s) and other controls, if any, shall be adjusted, as necessary, to a position which is likely to give storage temperatures (*see* **7.4** and **7.5**) which comply with **5.2.1**, after stable operating conditions (*see* **3.4.8**) have been attained.

12.2 Test Report

The test report shall contain at least the following information for each ambient test temperature (as appropriate):

a) Ambient temperature;
b) Setting(s) of thermostat(s) and other controls, if any (if designed for adjustment by the user);
c) Value of fresh food storage temperature t_m and the individual temperature values of t_1, t_2 and t_3;
d) Value of the cellar compartment t_{cm} and the individual values of t_{c1}, t_{c2} and t_{c3} as appropriate during a complete operating cycle;
e) Freezer temperature; and
f) The value of the recorded chill temperatures $t_{cc\ Max}$ and $t_{cc\ Min}$.

13 WATER VAPOUR CONDENSATION TEST

The purpose of this test is to determine the extent of condensation of water on the external surface of the cabinet under specified ambient conditions.

13.1 Procedure

13.1.1 *Ambient Temperature*

The ambient temperature shall be +32°C and shall be controlled within the tolerances specified in **7.1.1**.

13.1.2 *Relative Humidity*

The relative humidity shall be such that the dew point is 27°C ± 0.5°C.

13.1.3 *Preparation of the Appliance*

The setting(s) of the thermostat(s) and other controls, if any, the installation of the appliance shall be the same as for the energy-consumption test. The freezer compartment temperatures shall be −18°C and fresh food compartment temperature 0°C to +5°C.

If anti-condensation heaters are provided which can be switched on and off by the user, they shall not be switched on. If, however, the requirement of **4.3** is not fulfilled, the test shall be repeated with the anti-condensation heaters switched on.

The relative humidity can be measured using relative humidity sensor of ±3 percent accuracy.

13.1.4 *Test Period*

After stable operating conditions have been attained, all external surfaces of the cabinet shall be carefully wiped dry with a dean cloth and the test continued for a period of 24 h. The test period shall be selected during the period when condensation is most likely to occur.

13.2 Observation

During the test period, external surface areas exhibiting fog, droplets or running water shall be outlined and designated with the letters A, B and C respectively (*see* Fig. 12).

13.3 Expression of Results and Test Report

A coded sketch shall be made showing the maximum area and degree of condensation appearing during the test on all surfaces; the code shown in Fig. 12 shall be used.

The test report shall also indicate the selected test period and the duration of the period of observation and shall state whether any manual switch provided for anti-condensation heaters was switched on or off.

14 ENERGY CONSUMPTION TEST

The purpose of this test is to check the energy consumption of appliances under specified test conditions.

14.1 Procedure

14.1.1 *Ambient Temperature*

The ambient temperature shall be +32°C and shall be controlled within the tolerances specified in **7.1.1**.

14.1.2 *Preparation of the Appliance*

The appliance shall be installed in no load condition as for the storage temperature test (*see* **12.1**). If, however, anti-condensation heaters are provided which can be switched on and off by the user but are not necessary to withstand the water vapour condensation test (*see* **13**), they shall not be switched on If the appliance includes a cellar compartment and the volumes of this compartment and of the fresh food storage compartment are adjustable in relation to one another by the user, the cellar compartment shall be adjusted to its minimum volume.

14.1.3 *Location of Sensors*

a) *In unfrozen food storage compartments* — Air temperature sensor in unfrozen food storage compartments shall be located as shown in Fig. 8. Each location is midway between the front and rear of the compartment. Any sensor immediately below a sub-compartment formed by an evaporator shall be located under the plan centroid of the sub-compartment.

b) *In frozen food storage compartments* — Air temperature sensor in unfrozen food storage compartments shall be located as shown in Fig. 8.

c) *Equivalent positions* — Where it is not possible to place the temperature sensors in the positions specified in **14.1.3** (a) and (b), they shall be positioned as near as practicable to the specified locations in position which will provide an equivalent result. The positions of such locations shall be recorded in the test report.

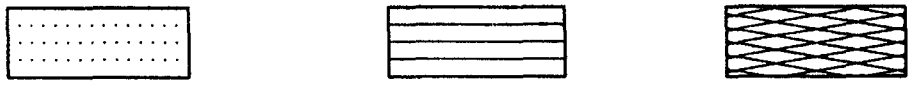
14.2 Measurements

The energy consumption shall be measured during the test period (*see* **7.6**).

The measurement of energy consumption shall be carried out under no load condition with all compartments simultaneously being in operation.

14.2.1 *General Temperature Conditions*

The lowest conceivable value of E_t (tested energy



A B C

KEY

A — fog
B — droplet
C — running water

FIG. 12 CONDENSATION CODE

consumption) for an appliance that is the theoretical optimum, is its energy consumption, over a 24 h period, during which the average temperature of freezer and refrigerator compartment is exactly equal to its target temperature.

As not every appliance is capable of operation at this condition, the practical optimum E_t of an appliance is its energy consumption, over a 24 h period, during which the temperatures of freezer and refrigerator compartments are at or below target temperatures and the temperature of all controlled compartments are as close to target temperature as can be achieved by adjustment of temperature controls on the appliance.

E_t shall be determined either by:

a) directly from the results of a single test run during which the temperatures of all compartments of the appliance are at or below the target temperatures.

b) interpolation between the results of two or more tests run, conducted at different settings of either one or two temperature controls, as follows:

   1) Where the setting of only one control is adjusted, the requirements of Annex A shall apply.

   2) Where the settings of two controls are adjusted, the requirements of Annex B shall apply.

   In both the cases, the test results must show that the temperatures of all the compartments of the appliances are at or below the target temperatures at the point of interpolation where E_t is determined.

c) *Target temperatures*

   Following are the temperatures to be maintained in the respective compartments as target temperatures:

   Fresh food refrigerator compartment : (+) 3°C

   Freezer compartment : (–) 15°C

d) For products where separate storage zones are defined such as cellar and chiller while determining the consumption, only freezer and refrigerator compartment temperature should be used for calculation. However, temperature in the defined compartments should be lower than their specific target temperature measured in Table 1.

14.2.2 *Number of Test Runs*

Testing options available for determining values of E_t depend on the numbers of user adjustable temperature controls on the appliance. These options are as follows:

a) Where a test appliance has one user adjustable controls, E_t shall be determined either,

   1) From the results of a single test run; or

   2) By an interpolation from the results of a minimum of two test run of the appliance with different settings of the control (*see* Annex A).

b) Where a test appliance has two user adjustable controls, E_t shall be determined in one of the following ways:

   1) In accordance with (a)(1).

   2) By an interpolation between the results of a minimum of two test run of the appliance with different settings of one control and with no change to the setting on the other (*see* Annex A).

   3) By an interpolation between the results of three test runs of the appliance with different settings of both controls (*see* Annex B).

14.3 Test Report

The value of the energy consumption shall be calculated from the measured value for a period of exactly 24 h.

The energy consumption of electrically operated appliances shall be expressed, in kilowatt hours per 24 h (kWh/24 h), to two decimal places.

15 TEMPERATURE RISE TEST (INFORMATIVE)

The purpose of this test is to check the time for the temperature rise of test packages in 'three star' storage under specified test conditions.

NOTE — This test is for information of manufacturer and would be applicable when use of test packages are specified.

15.1 Procedure

15 1.1 *Ambient Temperature*

The ambient temperature shall be in accordance with **7.1.1**.

15.1.2 *Preparation of the Appliance*

The appliance shall be prepared, stabilized in no load condition for the energy-consumption test (*see* **14**).

15.1.3 *Setting of Control Devices*

Thermostats and other controls (flaps, etc), if any, shall be set for –18°C for freezer compartment.

If the energy consumption was determined by interpolation from the results of two tests, the settings shall be those which gave the colder temperatures used for the interpolation.

15.2 Test Period and Measurements

At the moment of initiation of a defrosting cycle (*see* **3.4.5.2**) of the refrigerating system of the appliance, or of the system which refrigerates the food freezer compartment and any compartment having temperature not warmer than –18°C, the power supply to the appliance shall be cut off.

The period of time shall be noted from the moment when the temperature of the warmest measurement in the food freezer compartment (or cabinet) or in any compartment (or cabinet) reaches –18°C to the moment when any one of the measurements in any of these compartments (or cabinets) first reaches –9°C.

15.3 Test Report

The test report shall contain the following information:

a) Ambient temperature;
b) Time for the temperature rise from –18°C to –9°C; and
c) Whether the declared temperature rise time, if any, meets the requirements of **5.2.5**.

16 PULL DOWN TEST

16.1 Thermal Equilibrium

Pull down test rely on the whole refrigerating appliance including the inside, being in thermal equilibrium with the test room at 43°C before commencement of the test procedure.

16.2 Preparation of the Appliance

The appliance shall be installed in the test room in accordance with **7.1.3**. General test conditions given in **7.2.3**, **7.2.4** and **7.3** shall apply. Relative humidity shall be maintained between 45 percent and 75 percent.

With the test room ambient at 43°C and the appliance switched off, open all doors and lids on the appliance and let it stand to allow the whole appliance to reach to ambient conditions.

Close the door but do not switch on the appliance. The appliance be taken that it had reached the starting condition for pull down test, if over a period of 30 min the average compartment temperature in each compartment does not vary by more than 0.3°C.

16.3 Disconnection of Devices

Compressor overload devices shall not be disconnected nor bridged. Any other device which might prevent continuous operation of the refrigerating system during a pull down test shall be switched off, disconnected or bridged. This includes defrost devices and thermostats that switch the refrigerating system.

In case of use of adjustable compartment such as cellar and fresh food compartment, the fresh food compartment volume shall be adjusted to the lowest possible. The ambient temperature of the test room shall be maintained at 43°C during stabilization period and at 43.0 ± 0.5°C during the test.

16.4 Test Procedure

After attaining required starting condition, start the appliance and operate it until the average air temperature in every compartment is at or below its pull down temperature as given in Table 1, or for 6 h whichever is shorter.

16.5 Test Report

The test report shall contain the following information:

a) Period of operation of the appliance;
b) Average air temperature reached in each compartment;
c) Where applicable, any alternate positions for air temperature sensors;
d) Function selected for each multi-use compartment;
e) Position of each user adjustable baffle which may affect operation temperature in any space in the appliance;
f) Setting of all user adjustable temperature controls; and
g) Setting of all other user adjustable switches and controls also.

17 ICE-MAKING TEST (IF APPLICABLE)

The purpose of this test is to check the claim, if any, for the ice-making capability of the appliance.

NOTE — This test does not apply to automatic ice-makers.

17.1 Procedure

17.1.1 *Ambient Temperature*

The ambient temperature shall be +43°C and shall be controlled within the tolerances specified in **7.1.1**.

17.1.2 *Preparation of the Appliance*

The appliance shall be installed in the test room in accordance with **7.1.3** and set up as in service in accordance with the manufacturer's instructions. The means of access (doors or lids) shall be kept closed during the test.

The thermostat shall be set in accordance with the manufacturer's instructions. When no instructions are given, the thermostat position shall be the same as that for the storage temperature test (*see* **12**).

The cellar compartment, if any, shall be as small as possible (if the volume is adjustable), with temperature control devices (flaps, etc) set in the position in accordance with the manufacturer's instructions or the same as that for the storage test.

17.1.3 *Measurements*

After stable operating conditions (*see* **3.4.7**) have been attained, the ice tray(s) shall be filled with water up to 5 mm from the top and placed in the appliance at the position recommended by the manufacturer at the commencement of a defrosting cycle (*see* **3.4.5.2**).

If a sub-division is provided specifically for making and storing ice, and is not removable without the use of tools, the ice trays shall be placed in that sub-division.

The water temperature at the moment of placing the ice tray(s) in the appliance shall be +30°C ±1 K.

The ice tray(s) shall be examined for complete freezing of the water after an interval equal to the ice-making time stated by the manufacturer has elapsed or as estimated from the stated ice-making capabilities of the appliance.

17.2 Test Report

The test report shall contain the following information:

a) Quantity, in kilograms, of ice produced in a 24 h period or the time, expressed in hour and minute, necessary to freeze the water in the ice tray(s) supplied with the appliance; and

b) Whether the requirements in accordance with **5.2.4** are met.

18 TEST FOR ABSENCE OF ODOUR AND TASTE

The purpose of this test is to check that materials used for the internal components of the fresh food storage compartments and cellar and chill compartments, if any, will not impart either taste or odour to food.

18.1 Procedure

18.1.1 *Ambient Temperature*

The ambient temperature shall be between +16°C and +32°C.

18.1.2 *Cleaning*

The appliance shall be cleaned prior to the test in accordance with the manufacturer's instructions and afterwards with pure water.

18.1.3 *Thermostat Setting*

The appliance shall first be operated for 48 h, with the thermostat and other control devices set in a position which will give the following temperatures:

a) Fresh food storage compartment:

$$t_{am} = +5°C \pm 2\ K$$

b) Cellar compartment:

$$+8°C \leq t_{cm.s} \leq +14°C$$

c) Chill compartment:

$$-2°C \leq t_{cc}, \leq +3°C$$

18.1.4 *Samples*

The analytical samples and check samples respectively for each compartment shall be:

a) 100 ml potable water; and

b) A slice of fresh unsalted butter of dimensions 75 mm × 35 mm × 5 mm.

From each of (a) and (b), at least six samples are necessary to serve as analytical samples and at least six to serve as check samples.

The analytical samples shall be placed in petri dishes and the check samples in glass containers, the latter being hermetically sealed.

Prior to the test, all petri dishes and containers which are used for the test shall be cleaned with fuming nitric acid and subsequently washed with distilled water until the complete absence of odour is obtained.

The analytical samples of water and butter shall be placed uncovered in the fresh food storage, cellar and chill compartments.

The check samples in the hermetically sealed glass containers shall be placed close to the analytical samples.

18.1.5 *Test Period*

The analytical samples and the check samples shall be left in the operating appliance with the door(s) closed and at the specified temperature conditions for 48 h. After 48 h, the analytical samples shall be covered.

Then the analytical samples and check samples shall be removed and warmed up to approximately 20°C by leaving them in the test room.

18.2 Examination of Samples

18.2.1 *Conditions*

Examination shall be made about 2 h after removal of the samples from the appliance and shall be carried out by at least three expert assessors familiar with the test method.

Each expert assessor shall receive;

a) two analytical samples of water;

b) two check samples of water;

c) two analytical samples of butter; and
d) two check samples of butter.

The identity of the samples shall not be made known to the expert assessors. Examination for odour shall do carried out before examination for taste.

The samples of water shall be examined prior to the samples of butter, unless a separate examination by different expert assessors takes places.

The examiners shall record their remarks, independently of each other, in writing.

18.2.2 *Evaluation*

The evaluation of the analytical samples shall be carried out with reference to the following scale:

a) Mark 0 : No foreign odour or foreign taste;
b) Mark 1 : Slight foreign odour or foreign taste;
c) Mark 2 : Definitely perceptible foreign odour or foreign taste; and
d) Mark 3 : Distinct foreign odour or foreign taste.

If the requirement in accordance with **4.2** is not clearly met, the test shall be repeated. The following provisions shall be made for the second test:

a) Cleaning of the compartments;
b) Operation of the empty appliance for one week; and
c) Temperature adjustment in the fresh food storage, cellar and chill compartment for the second test for absence of odour and taste.

18.3 Test Report

The test report shall indicate the evaluation and whether the requirements of **4.2** are met.

19 HIGH VOLTAGE TEST

The electrical insulation of all electric circuits included in the refrigerator shall be such as to withstand a high voltage test of 1 000 V rms applied for not less than two seconds between all electric circuits and all accessible metal parts (electrically connected together for this test) at normal room temperature. For refrigerators to be connected to circuits of 50 V and below the high voltage shall be 500 V rms. The test voltage shall be alternating, of approximately sinewave form, and of any convenient frequency between 25 and 100 Hz.

20 INSULATION RESISTANCE TEST

Insulation resistance between all electrical circuits included in the freezer and the earthed metal parts when measured at normal room temperature with dc voltage of 500 V shall not be less than one mega ohm.

21 FINAL TEST REPORT

The final test report shall comprise the measurements and test results of the following:

a) Overall dimensions (*see* **3.3.3**);
b) Overall space required in use (*see* **3.3.4**);
c) Total gross volume (*see* **3.3.5.3** and **6.2.1**);
d) Storage volume(s) (*see* **3.3.5.5**, **6.2.3**, **6.2.4** and **6.2.5**);
e) Total storage volume (*see* **3.3.5.7** and **6.2.2**);
f) Storage shelf area (*see* **3.3.6.2** and **6.3**);
g) Air tightness of door(s) or lid(s) (*see* **8**);
h) Opening force test of door(s) or lid(s) (*see* **9**);
j) Durability test (*see* **10**);
k) Mechanical strength test (*see* **11**);
m) Water vapour condensation test (*see* **13**);
n) Energy-consumption test (*see* **14**);
p) No load pull down test (*see* **16**);
q) Ice-making test, if applicable (*see* **17**);
r) Absence of odour and taste test (*see* **18**);
s) High voltage test (*see* **19**); and
t) Insulation resistance test (*see* **20**).

22 ADDITIONAL REQUIREMENTS FOR ECO-MARK

22.1 The refrigerator shall conform to the requirements for quality, safety and performance prescribed in **4** to **20** and **22**.

22.2 The manufacturer shall produce the consent clearance as per the provisions of *Water (Prevention and Control of Pollution) Act*, 1974; *Water (Prevention and Control of Pollution) Cess Act*, 1977 and *Air (Prevention and Control of Pollution) Act*, 1981 along with the authorization, if required under the *Environment (Protection) Act*, 1986 to BIS while applying for ECO-Mark.

22.3 Noise Level

For ECO-Mark the refrigerator shall conform to the noise levels as notified under the *Environment (Protection) Act*, 1986 from time-to-time.

22.4 Instructions

The refrigerator shall be sold along with instructions for proper use so as to maximize product performance, minimize wastage and method of safe disposal of used product.

22.5 Energy Consumption

The energy consumption shall be at least 5 percent less than those specified in **5.2.3**.

22.6 Refrigerants which are ozone depleting such as CFC 11/12 as identified under Montreal Protocol shall not be used in the manufacture of these refrigerators.

22.7 Packing

The refrigerator shall be packed in such packages, which are made of recyclable or biodegradable materials.

23 DESIGNATION

Household appliances shall be designated according to:

a) kind (for example, single door or double door, frost-free refrigerator, food freezer, etc);
b) operating principle (compression);
c) class (tropical — T);
d) rated total gross volume, either in cubic decimetre or in litre;
e) rated total storage volume, either in cubic decimetre or in litre, together with the rated storage volume of the food freezer compartment, and the star classifications(s) and rated storage volume(s) of any frozen food storage compartment(s) and any 'two star' section(s), if applicable; and
f) pull down time, in min.

Example of designation

Two-door compression-type, frost-free household refrigerator-freezer, class T, total gross volume 400 dm^3, total storage volume 360 dm^3, including a food freezer compartment having 42 dm^3 'three star' and 8 dm^3 'two star' volume, pull down time 240 min.

24 MARKING

24.1 Rating Plate

Each appliance shall have,one or several securely fastened rating plates, the following information marked in a permanent and legible manner, either preferably readily visible in normal use or when the appliance is away from a wall or after the removal, without any tool, of a flap or grille:

a) Indication 'frost-free refrigerator', 'frost-free refrigerator-freezer';
b) Trade-mark or name of the manufacturer;
c) Model designation;
d) Serial number and/or date of manufacture, which may be coded;
e) Rated storage volume, either in cubic decimetres or in litres, of the following:
   1) the food freezer compartment (excluding any compartment having temperature not warmer than −12°C or compartment therein),
   2) the fresh food storage compartment,
   3) the cellar compartment, if any; and
   4) the chill compartment(s), if any;
f) Rated total gross volume, either in cubic decimetres or in litres; Gross volume shall be marked in 'normal letters' below or after Storage volume;
g) Symbol of the class (T);
h) Designation and mass, in gram, of the refrigerant (*see* IS 10609); and
j) All information relating to the energy source, including those laid down by safety regulations;

NOTE — Storage volume shall be marked in bold letters whereas gross volume shall be marked in 'normal letters' in smaller font size to that of 'Storage volume'.

Items (a) to (f) (necessary for service) shall be visible when the appliance is in its position for normal use.

The manufacturer may give/indicate any other information considered desirable.

24.2 Additional Marking

In addition to markings given in Rating Plate, the Storage Volume and Gross Volume shall also be displayed on front of refrigerator in the manner specified **24.1**.

24.3 Identification of Food Freezer and Food Freezer Compartments

Food freezers and food freezer compartments (as specified in **3.1.4** and **3.2.6**) shall be identified by a symbol placed on their front, doors or lids, conforming to that shown in Fig.13 and defined as follows: a rectangular frame enclosing a large six-pointed star followed by the symbol for a 'three star' frozen food storage compartment.

In the case of a 'two star' section in a food freezer compartment/cabinet, the standard two star symbol shall appear close to the standard four star symbol wherever it appears.

If the exterior of the appliance is intended to be decorated by the purchaser, and the symbol would then be hidden, the symbol shall be placed on the appropriate compartment inside the appliance.

The dimensions shall be such that the height of the large star is equal to the height of the curved frame at its midpoint (the long axis of the frame being horizontal).

The symbol shall not make use of more than two colours or exhibit more than two contrasting surface finishes. The colour (or the surface finish) of the large star shall

be different from that of the three other stars. (For the purpose of this requirement, white and black are considered as colours.) There shall be no marking or decoration anywhere on the appliance which could be confused with the food freezer identification symbol.

24.4 Identification of Frozen Food Storage Compartments (or Cabinets)

Frozen food storage compartments (or cabinets) shall be identified by a symbol, placed on either front, doors or lids. In the case of a 'two star' section in a 'three star' food storage compartment/cabinet, the standard two star symbol shall appear close to the standard three star symbol wherever it appears. Six-pointed stars within a frame with curved sides, as shown in Fig. 14, shall be used for the identification on the compartments (or cabinets) as specified in **3.1.3** and **3.2.6**.

If the exterior of the appliance is intended to be decorated by the purchaser, and the symbol would then be hidden, the symbol shall be placed on the appropriate compartment inside the appliance.

The symbol shall not make use of more than two colours or exhibit more than two contrasting surface finishes. (For the purpose of this requirement, white and black are considered as colours.) There shall be no marking or decoration anywhere on the appliance which could be confused with the star identification symbols.

NOTE — A text and symbol for the identification of a chill compartment will be added when defined.

25 TECHNICAL AND ADVERTISING LITERATURE

Whenever technical and advertising literature is supplied, it should contain the characteristics stated in **23** and if, additionally, it contains all or some of the following data, such data shall be in accordance with this standard:

a) Name of manufacturer or responsible vendor;
b) Model designation;
c) Range of ambient temperature for which the appliance is designed;
d) Overall space required in use (*see* **3.3.4**), with sketches showing the appliance with the means of access open and closed;
e) For appliances which are intended to be built-in, the recess dimensions, together with any additional ventilation requirements;
f) Direction of opening of the door(s), and whether reversible;
g) Rated energy consumption (*see* **14**), with a reference to the ambient temperature at which the value was measured;
j) Pull down time, measured in accordance with **16**;
k) Ice-making capability, measured in accordance with **17**, if applicable;
m) Rated total storage volume, measured in accordance with **6.2**;

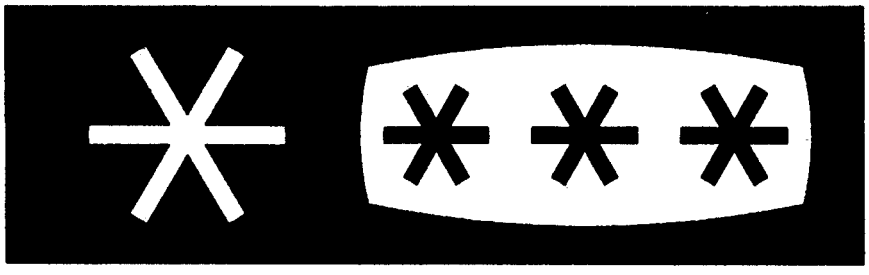


FIG. 13 IDENTIFICATION SYMBOL FOR FOOD FREEZER AND FOOD FREEZER COMPARTMENTS

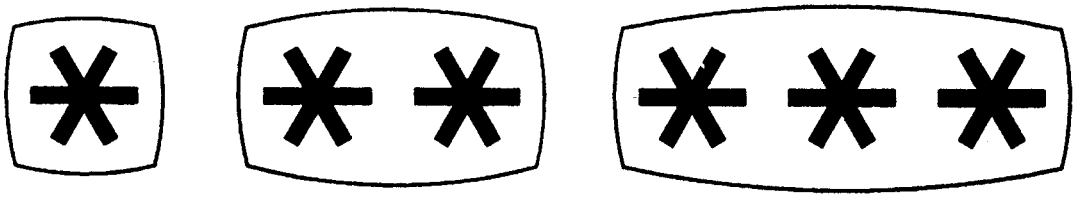


FIG. 14 IDENTIFICATION SYMBOL FOR FROZEN FOOD STORAGE COMPARTMENTS (OR CABINETS)

n) Rated storage shelf area, measured in accordance with **6.3**;

p) Range of voltage; and

q) Minimum clearance to be maintained from surrounding walls.

26 INSTRUCTIONS FOR USE AND MAINTENANCE

Every appliance shall be accompanied on delivery by instructions for its use and maintenance. These instructions shall include, in particular, information as to:

a) Installation requirements (best location, levelling, connection — if required — for defrost water, connections to energy source);

b) Overall space required in use (*see* **3.3.4**), with sketches showing the appliance with the means of access open and closed;

c) For appliances which are intended to be built-in, the recess dimensions together with any additional ventilation requirements;

d) Operating conditions (starting and stopping procedures);

e) Instructions for use of the various controls [such as thermostat(s), fast freeze switch, indicator lights, air circulation and defrosting control(s)];

f) Limit values of the range of ambient temperature for the climate class for which the appliance is designed and the fact that the internal temperatures may be affected by such factors as the location of the appliance, ambient temperature and the frequency of door opening. If appropriate, a warning shall be given that the setting of the thermostat or other temperature control devices might have to be varied to allow for these factors;

g) Care required for best performance, such as:

1) loading the appliance [and especially when the storage volume of the food freezer compartment (or cabinet) or any 'three star' compartment(s) (or cabinet) is smaller than the corresponding gross volume and when no load limit lines exist];

2) the use of baskets and where appropriate, a warning on the risk of poor performance when the baskets are not used;

3) the arrangement of food for storage, in particular the need to avoid cross-contamination;

4) the arrangement of food for storage and for freezing, where applicable, including, in particular, advice that food to be frozen shall not be placed in direct contact with food in storage and if appropriate, that it may be necessary to reduce the quantity to be frozen if freezing every day is anticipated; and

5) in the case of appliances with chill compartments, it should be stated that some types of fresh vegetables and fruit are sensitive to cold; therefore they are not suitable for storage in this kind of compartment.

h) Maintenance and cleaning of the appliance;

j) Fact that effervescent drinks should not be stored in food freezer compartments (or cabinets) or in low-temperature compartments (or cabinets), and that some products such as water ices should not be consumed too cold;

k) Need not to exceed the storage time(s) recommended by the food manufacturers for commercially quick frozen food in food freezer and frozen food storage compartments (or cabinets);

m) Care required with regard to frozen food in storage in the event of an extended non-running of the appliance (interruption of power supply or failure of the refrigerating system);

n) Action to be taken when the appliance is switched off and taken out of service temporarily or for an extended period, for example, emptied, cleaned and dried, and the door(s) or lid(s) propped a jar; and

p) Necessity that, for doors or lids fitted with locks and keys, the keys should be kept out of the reach of children and not in the vicinity of the appliance, in order to prevent children from being locked inside.

27 BIS CERTIFICATION MARKING

27.1 Each refrigerator may also be marked with the Standard Mark.

27.2 The use of the Standard Mark is governed by the provisions of *Bureau of Indian Standards Act*, 1986 and the Rules and Regulations made thereunder. The details of conditions under which a licence for the use of the Standard Mark may be granted to the manufacturers or the producers may be obtained from the Bureau of Indian Standards.

ANNEX A

(*Clauses* 14.2.1 *and* 14.2.2)

METHOD OF INTERPOLATION WHEN ONLY ONE CONTROL IS ADJUSTED

A-1 This method applies to the appliance where two or more compartments are affected by the adjustment of the single temperature control.

This Annex sets out the method for determining a value of tested energy consumption (E_t) of a appliance by interpolation between the results of two test runs where the settings of one temperature control only is adjusted and while all other controls and baffles, are on settings that remain unchanged. Interpolation may be performed either mathematically or graphically.

The value of E_t determined by this method is an approximation to the value of E_t which would be obtained when the control concerned is adjusted to a setting that brings the temperatures of the compartment affected as close as possible to, while not above, target temperatures. This value of E_t will approximate to the optimum value of E_t that is obtainable by adjustment of that control while other controls and baffles, if any, are on the settings at which the test was conducted.

The interpolation process is applied to each compartment and the tested energy consumption is determined for the point at which the first compartment crosses above its target temperature. This corresponds to the point where the compartment in question would be at its target temperature and the other compartment is below their respective target temperature.

In cases where, for any relevant compartment, three or more test points have been obtained but no two points are sufficiently close to the target temperature to perform a linear interpolation, it is acceptable to interpolate using a polynomial equation through these points.

NOTE — Any compartment which lie below their target temperature for all relevant test points do not have to meet any other temperature conditions and can be ignored during interpolation calculations.

A-2 MINIMUM REQUIREMENTS FOR INTERPOLATION

Interpolation can be performed by either linear interpolation using results from two control settings or by interpolation of a curve using results from three or more control settings. In either case, the interpolation may be performed either mathematically or graphically.

A-2.1 Linear Interpolation

Linear interpolation using results for only two control settings can be undertaken on all compartments where measured temperatures lie both above and below their target temperatures and either:

a) Both points lie within ±2°C of the target temperature for each compartment; or

b) One point lies within ±1°C of the target temperature for that compartment and one point lies within ±4°C of the target temperature.

A-2.2 Interpolation Along a Curve

Interpolation along a curve using results for three control settings can be undertaken on all compartments where

a) One point lies within ±2°C of the target temperature for that compartment;

b) One point is warmer than the target temperature; and

c) One point is colder than the target temperature.

A-3 CALCULATIONS

A-3.1 The interpolation shall be performed according to one of four methods as follows:

a) Linear interpolation for one compartment above target temperature.

b) The calculated energy consumption rate E_x is given by the equation:

$$E_x = E_1 + \left[(E_2 - E_1) \times \frac{(t_x - t_1)}{(t_2 - t_1)} \right] \quad \ldots(1)$$

where

E_x = calculated energy consumption rate of the appliance at the target temperature t_x,

E_1 = measured energy consumption rate of the appliance for point 1,

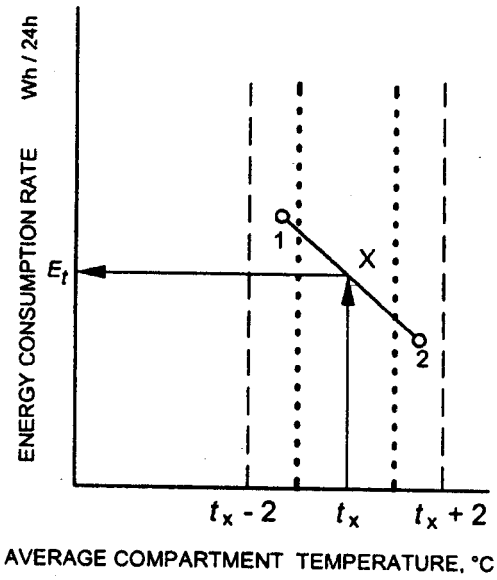
E_2 = measured energy consumption rate of the appliance for point 2,

t_1 = measured compartment temperature for point 1, and

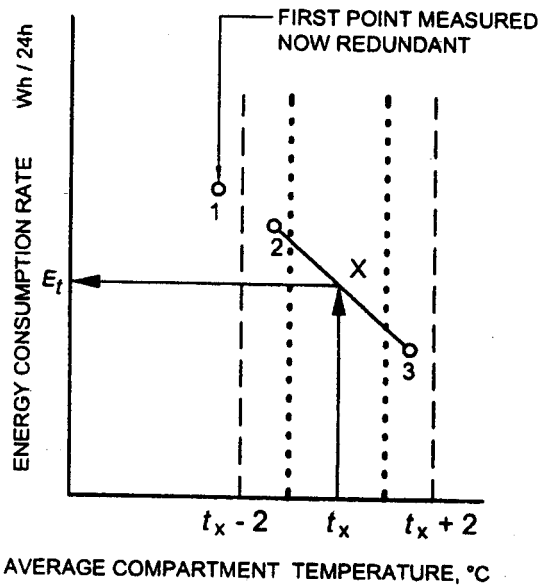
t_2 = measured compartment temperature for point 2.

c) The tested energy consumption (E_t) is then equal to E_x.

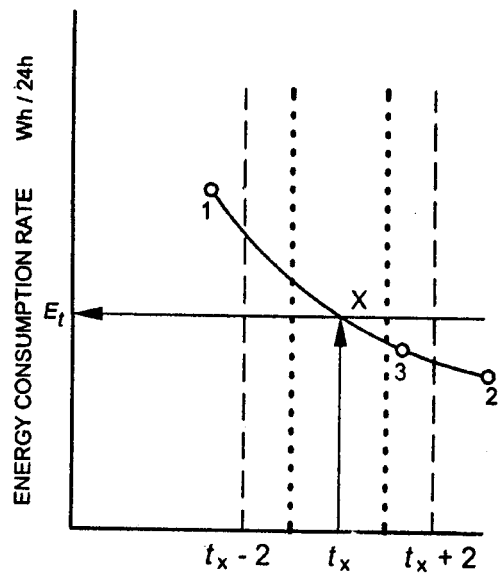
d) alternatively, the tested energy consumption may be determined by graphical interpolation [*see* Fig. 15(a) and 15(b)].



a) TWO POINTS, ONE EITHER SIDE OF t_x AND BOTH WITHIN RANGE t_x ±2 °C



b) THIRD POINT REQUIRED AS FIRST TWO POINTS DID NOT SATISFY THE REQUIREMENTS. ONLY POINTS 2 AND 3 USED FOR LINEAR INTERPRETATION.



c) A THIRD POINT IS REQUIRED AS THE FIRST TWO POINTS DID NOT SATISFY THE REQUIREMENTS. THE THREE POINTS DEFINE THE CURVE.

FIG. 15 EXAMPLES OF GRAPHICAL DETERMINATION OF TESTED ENERGY CONSUMPTION (E_t) OF A REFRIGERATING APPLIANCE WITH A SINGLE TEMPERATURE CONTROL FOR A SINGLE COMPARTMENT

A-3.2 Linear interpolation more than one compartment above target temperature.

A-3.2.1 Nominate each relevant compartment as compartment A, B, C, etc.

A-3.2.2 Applying equation (1) to RC and FC compartment, calculate the energy consumption rate of the appliance at the target temperature of each compartment that is E_{xR}, E_{xF}.

A-3.2.3 The tested energy consumption (E_t) is determined by the compartment which rises above its target temperature first. Therefore, the tested energy consumption E_t is the maximum of all E_X values calculated in **A-3.2.2.**

$$E_t = \text{Max}\ (E_{xA}, E_{xB}, E_{xC} \ldots) \qquad \ldots(2)$$

A-3.2.4 Alternatively, the tested energy consumption may be determined by graphical interpolation [*see* Fig. 16(a) and 16(b)].

A-3.3 Interpolation by polynomial equation for one compartment above target temperature. The calculated energy consumption rate E_x shall be determined by solving the quadratic equation of the line passing through the three values of the measured energy consumption rate and measured compartment temperature for the compartment target temperature t_x as set out below.

A-3.3.1 Calculate the energy consumption rate E_x of the compartment at the target temperature t_x as shown in the following equation:

$$E_x = (a \times t_x^2) + (b \times t_x) + c \qquad \ldots(3)$$

The tested energy consumption E_t for the test is then equal to E_X.

Alternatively, the tested energy consumption may be determined graphically [*see* Fig. 15(c)].

Solve the coefficients a, b, and c of the quadratic equation for the values of t_1, t_2, t_3, E_1, E_2 and E_3.

$$E_1 = at_1^2 + bt_1 + c \qquad \ldots(4)$$

$$E_2 = at_2^2 + bt_2 + c \qquad \ldots(5)$$

$$E_3 = at_3^2 + bt_3 + c \qquad \ldots(6)$$

The solution to these equations is as follows:

$$b_{top} = E_3t_2^2 - E_3t_1^2 - E_2t_3^2 + E_2t_1^2 + E_1t_3^2 - E_1t_2^2 \qquad \ldots(7)$$

$$b_{bottom} = t_3t_2^2 - t_3t_1^2 - t_2t_3^2 + t_2t_1^2 + t_1t_3^2 - t_1t_2^2 \qquad \ldots(8)$$

$$b = b_{top}/b_{bottom} \qquad \ldots(9)$$

$$a = (E_2 - E_1 + bt_1 - bt_2)/(t_2^2 - t_1^2) \qquad \ldots(10)$$

$$c = E_1 - bt_1 - at_1^2 \qquad \ldots(11)$$

A-3.3.2 The tested energy consumption E_t for the test is then equal to E_x.

A-3.3.3 Alternatively, the tested energy consumption may be determined by graphical interpolation [*see* Fig. 16(c)].

A-3.4 Interpolation by polynomial equation for more than one compartment above target temperature.

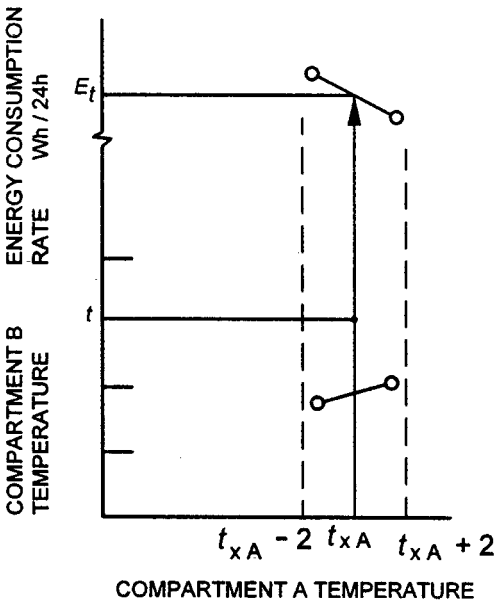
A-3.4.1 Nominate each relevant compartment as compartment A, B, C, etc.

A-3.4.2 For each compartment solve the coefficients a, b, and c of the quadratic equation for the values of t_1, t_2, t_3, E_1, E_2 and E_3.

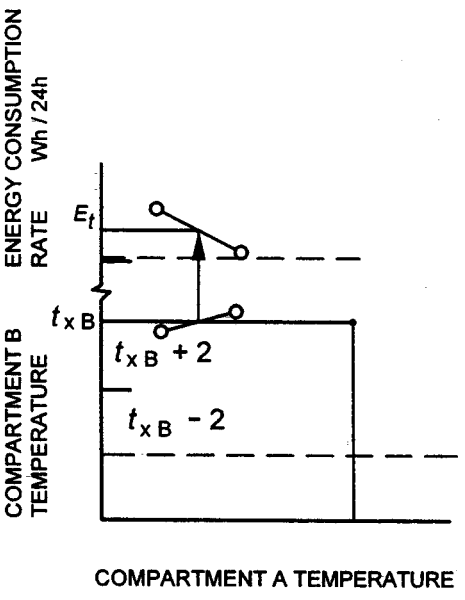
A-3.4.3 Applying equation (3) to each compartment, calculate the energy consumption rate of the appliance at the target temperature of each compartment, that is E_{xA}, E_{xB}, E_{xC} etc.

A-3.4.4 The tested energy consumption E_t is the maximum value of E_{xA}, E_{xB}, E_{xC}.

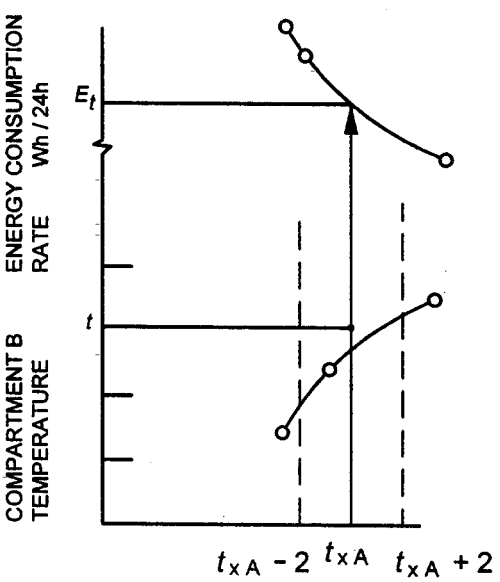
A-3.4.5 Alternatively, the tested energy consumption may be determined by graphical interpolation [*see* Fig. 16(c)].



a) COMPARTMENT A TEMPERATURE CRITICAL



b) COMPARTMENT B TEMPERATURE CRITICAL



c) COMPARTMENT A TEMPERATURE CRITICAL (PARABOLA)

FIG. 16 EXAMPLES OF GRAPHICAL DETERMINATION OF TESTED ENERGY CONSUMPTION (E_t) OF A REFRIGERATING APPLIANCE WITH A SINGLE TEMPERATURE CONTROL AND TWO COMPARTMENTS

ANNEX B

(Clauses 14.2.1 *and* 14.2.2)

METHOD OF INTERPOLATION WHEN TWO CONTROLS ARE ADJUSTED

B-1 This method applies to the appliance where two or more compartments are affected by the adjustment of the two temperature controls.

This Annex sets out the method for determining a value of tested energy consumption (E_t) of a appliance by interpolation between the results of three test runs where the settings of two temperature controls are adjusted and while all other controls and baffles, if any, are on settings that remain unchanged. Interpolation may be performed either mathematically or graphically.

The value of E_t determined by this method is an approximation to the value of E_t which would be obtained when the two controls concerned are adjusted to a settings that brings the temperatures of the compartments affected as close as possible to, while not above, target temperatures(point *Q*, *see* Fig. 17). This value of E_t will approximate to the optimum value of E_t that is obtainable by adjustment of those two controls while other controls and baffles, if any, are on the settings at which the test was conducted. The value is obtained by linear interpolation from a series of test points which surround the point of intersection of the compartment target temperatures.

Where the test appliance has more than two compartments, the performance of additional compartments shall not be considered for the calculation for E_t.

B-2 MINIMUM REQUIREMENTS FOR INTERPOLATION

B-2.1 There shall be a minimum of three energy consumption measurements at three setting combinations of two controls being adjusted.

B-2.2 The test points selected for analysis shall form a triangle which encloses the intersection of the target temperatures for those two compartments (point *Q*, *see* Fig. 17).

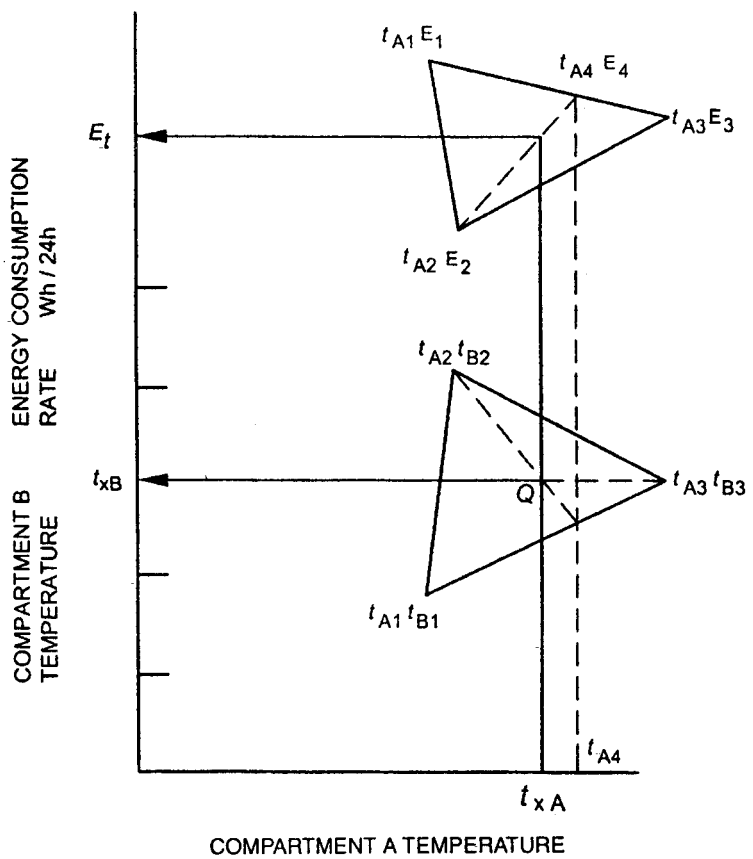


FIG. 17 EXAMPLES OF GRAPHICAL DETERMINATION OF ENERGY CONSUMPTION OF A REFRIGERATING APPLIANCE WITH TWO TEMPERATURE CONTROL FOR TWO COMPARTMENTS

B-2.3 The temperature in each compartment used in the interpolation shall lie within the range ±4°C for all three control setting combinations selected. (This is to ensure that interpolations over large temperature ranges do not lead to inaccurate results.)

B-3 CALCULATIONS

The following calculations shall be performed.

B-3.1 Use the notation as follows:

A graphical representation of these results is shown in Fig. 17.

t_{xA} = target temperature in compartment A,

t_{A1} = measured temperature in compartment A for control setting combination 1,

t_{A2} = measured temperature in compartment A for control setting combination 2,

t_{A3} = measured temperature in compartment A for control setting combination 3,

t_{A4} = calculated temperature in compartment A at a theoretical point 4,

t_{xB} = target temperature in compartment B,

t_{B1} = measured temperature in compartment B for control setting combination 1,

t_{B2} = measured temperature in compartment B for control setting combination 2,

t_{B3} = measured temperature in compartment B for control setting combination 3,

E_1 = energy consumption rate of the unit at control setting combination 1,

E_2 = energy consumption rate of the unit at control setting combination 2,

E_3 = energy consumption rate of the unit at control setting combination 3,

E_4 = calculated energy consumption rate of the unit at a theoretical point 4, and

E_x = calculated energy consumption rate of the unit when the target temperature t_{xA} in compartment A and t_{xB} in compartment B are achieved concurrently.

B-3.2 Ensure that result of the three control setting combinations used for calculations enclose the point Q.

B-3.3 Using the following equation, calculate the temperature in compartment A of a theoretical 4th point which lies at the intersection of the line joining points 1 and 3 and another line which passes through 2 and point Q:

$$t_{A4} = \frac{t_{XB} - \frac{t_{XA}(t_{B2} - t_{XB})}{(t_{A2} - t_{XA})} - t_{B1} + \frac{t_{A1}(t_{B3} - t_{B1})}{(t_{A3} - t_{A1})}}{\frac{(t_{B3} - t_{B1})}{(t_{A3} - t_{A1})} - \frac{(t_{B2} - t_{XB})}{(t_{A2} - t_{XA})}} \quad ...(12)$$

B-3.4 Check that the test points selected for analysis meeting the condition **B-2.2** (of minimum requirements of interpolation). To verify that the points selected meet this condition, the temperature in compartment A for point 2 must lie on the opposite side of the target temperature to the calculated temperature in compartment A for point 4. That is, one of the following two conditions shall be met:

$$t_{A4} < t_{xA} < t_{A2} \text{ or}$$
$$t_{A4} > t_{xA} > t_{A2}$$

If neither of these conditions is met, further testing shall be undertaken.

B-3.5 Calculate the energy consumption rate of the unit at a temperature of t_{A4} in compartment A using the measured energy consumption rate and the compartment A temperature data for points 1 and 3 as follows:

$$E_4 = E_1 + \left[(E_3 - E_1) \times \frac{(t_{A4} - t_{A1})}{(t_{A3} - t_{A1})} \right] \quad ...(13)$$

B-3.6 Calculate the energy consumption rate for the unit at point Q by interpolating the energy consumption rate at point 4 (from **B-3.5** above) with the energy consumption rate at point 2 at the target temperature t_{xA} in compartment A as follows:

$$E_X = E_2 + \left[(E_4 - E_2) \times \frac{(t_{XA} - t_{A2})}{(t_{A4} - t_{A2})} \right] \quad ...(14)$$

For these calculations, the order of the points is unimportant, as long as the numbering is consistent throughout.

B-3.7 The tested energy consumption E_t for the test is then equal to E_x.

B-3.8 Alternatively, the tested energy consumption may be determined by graphical interpolation (*see* Fig. 17).

ANNEX C

(Foreword)

COMMITTEE COMPOSITION

Refrigeration and Air-conditioning Sectional Committee, ME 03

Organization	*Representative(s)*
Veermata Jijabai Technological Institute, Mumbai	PROF K. G. N. KHEDKAR (***Chairman***)
All India Air-conditioning and Refrigeration Association, New Delhi	SHRI RAJENDRA MITTAL SHRI RAJEEV KAPIL (*Alternate*)
Annapurna Electronics and Services Ltd, Hyderabad	SHRI G. K. PRASAD SHRI PREM CHANDER (*Alternate*)
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BPL Compressors Unit, Patacheru	SHRI ASHOK K. GUPTA SHRI MANISH GUPTA (*Alternate*)
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Central Power Research Institute, Bangalore	SHRI K. MANOHARA SHRI GUJJALA B. BALARAJA (*Alternate*)
Confederation of Indian Industry, Kolkata	SHRI V. AZHAKESHAN SHRI A. HIRANANDANI (*Alternate*)
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Indian Institute of Technology, New Delhi	SHRI SANJEEV JAIN SHRI P. M. V. SUBBARAO (*Alternate*)
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